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EDITORIAL

SOIL EROSION.

IT will be remembered that a recent number of *The Tropical Agriculturist* contained an interesting account by Mr. E. O. Felsinger of a system of checking soil erosion by controlling the flow of water off the land. Interest in Mr. Felsinger's method has been widespread, and, as it is unlikely that any single method will prove efficacious or be adoptable under the varied conditions which exist in different parts of Ceylon, it is hoped that further interest will be displayed in the account of Mr. C. C. du Pré Moore's method which appears in the present number.

Mr. du Pré Moore claims that his system retains the top soil in its original site and prevents it from being moved down the slope, and also that it conserves soil moisture through its giving rain water an opportunity of soaking into the soil instead of running rapidly down the slope. It will be seen from the photograph and diagram which are published in Mr. du Pré Moore's paper that the eventual result of his system is the formation of a series of more or less level terraces on the hill side. Each terrace is a catchment area and a field inspection shows that the growth and appearance of young tea on the terraces are excellent. It has been found in practice that there is little or no danger of the collapse of the bunds constructed above the contour trenches and the cleaning of the trenches is not an expensive item.

Mr. du Pré Moore has experimented with three or four systems of contouring, bunding and terracing and has come to the conclusion that the system now described can be guaranteed to give good results. It resembles to some extent a system of preventing loss of soil in rubber land described by Mr. R. P. Hunter in *The Planter's Journal and Agriculturist* of October 15, 1928. The latter system differs in employing large pits, the soil from which is bunded and consolidated above the pits to form terraces and in the necessity for excavating to form the terraces. Mr. Hunter claims that his system has led to a large increase of yield and to the conversion of yellow-leaved trees into those of a dark and strong foliage. While the best results of Mr. du Pré Moore's system seem to be shown at present in young tea, there is no reason why the system should not be applied with success to older areas.

The paper by Dr. Haines of the Rubber Research Institute of Malaya, which is reproduced as a selected article, should be studied with care by those who are interested in the subject of soil conservation. It brings forward certain important principles which underlie the question at issue and which ought to be taken into consideration in the establishment of a scheme involving terracing, trenching and pitting.

ORIGINAL ARTICLES.

PREVENTION OF SOIL EROSION IN NEW CLEARINGS.

C. C. DU PRÉ MOORE,
HUNASGERIYA GROUP, WATTEGAMA.

A good deal has been written on soil erosion and many systems have been advocated, but few suggestions seem to have been advanced for its prevention in the first instance. It is evident that the initial mistake was made when the land was first opened. The system of draining adopted tended to encourage both wet and dry wash and it had another distinct disadvantage inasmuch as the subsoil cut from the drains filled the interval between them and smothered the active soil bacteria which are so essential to the growth of the plant. The tendency for the soil to travel downwards was increased every time the drains were cleared and the holes for planting were, more often than not, filled with subsoil. Soluble organic matter, together with the finer soil, was swept away in the drain water, and, in course of time, bare washed hillsides remained. It seems incredible that terracing has only come into favour of late years, more especially as such excellent examples, which have stood the test of time, surround the planting districts.

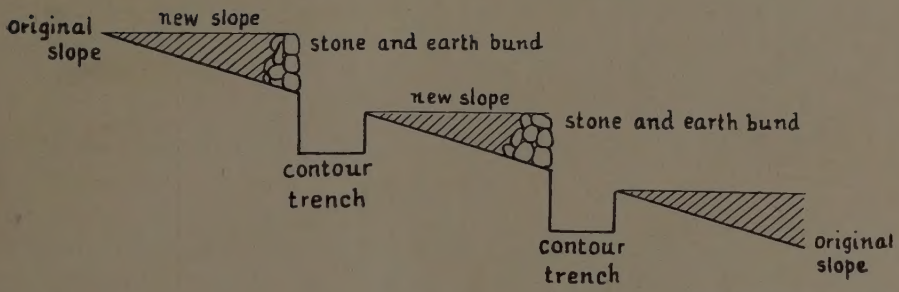
The writer, after a series of experiments, has evolved a system of opening land which has proved so successful that he is tempted to give a short account of his work in the hope that it may be of some value to the planting community.

Contouring the hill sides with level trenches, as opposed to drains, the earth from which is made into a bund on the upper side of the trench, is the plan adopted. If stone is available in quantity the terraces can be built and the contour trenches cut one foot below each terrace, the earth being bunded up above the terrace. This is of course a stronger method and greatly tends to decrease the incidence of slope between the terraces. The distance between contours depends entirely on the lie of the land but the general rule is to measure off equal distances down the greatest slope. In making the bunds the coolie is careful to pile the earth neatly above the trench or terrace, if stone has been available, and this is hammered and consolidated. These bunds will be found

capable of holding all rain water and there will be no movement of the soil. Humus is carefully preserved and no soluble matter is lost in drain water.

In dealing with grass land, burning should not be allowed, the grass being merely uprooted and allowed to remain *in situ*. This will protect the surface from wash until contouring has been finished and will in time rot down and form good mould which is, of course, a valuable plant food. If seed-at-stake is to be planted no holing will be necessary, the ground being prepared with a fork. The young plants grow better this way as their roots get rapidly into the surrounding loose earth.

The cost of opening, including cost of seed, works out at Rs. 245 per acre. A small 5-acre clearing, opened in 1925, came into bearing this year and has already given 500 lbs. made tea per acre.



BLOCK BY SURVEY DEPT. CEYLON.

EXPERIMENTS WITH LIMES *(CITRUS MEDICA* L. VAR. *ACIDA)* IN THE NORTH CENTRAL PROVINCE.

H. A. DEUTROM,

MANAGER, EXPERIMENT STATION, ANURADHAPURA.

THE following records of experimental cultivation of limes at the Experiment Station, Anuradhapura, are of interest and may stimulate the cultivation of this useful crop. That a certain amount of interest is being aroused is proved by the fact that orders for plants and seed are received daily at the Experiment Station.

The juice of the lime is employed for the manufacture of cooling drinks, especially lime juice cordial, and is also used for flavouring soups, curries and fish. It imparts a pleasant acid taste and agreeable flavour. The fruit is pickled and is also largely used. Concentrated lime juice forms one of the principal sources of commercial citric acid. Essential oil of limes and distilled oil are of value in perfumery.

LAND AND RAINFALL.

Lime trees are surface-feeders and develop best and yield the heaviest crops in well-sheltered flat or gently-undulating land situated from sea level up to 2,500 feet elevation and possessing a rainfall varing from 60 to 150 inches per annum. The lime, however, can be successfully grown under other conditions provided there is sufficient rainfall and not too prolonged a dry season. Situations exposed to strong winds are not recommended.

NURSERIES.

A good site should be selected for the seed bed, an aspect which catches the morning sun being best. It should, moreover, be high and dry during wet weather. The soil should be worked up into a fine tilth and laid out in beds 3 feet wide and of any convenient length. To prepare seeds for sowing, the fruit should be chosen from heavy-yielding trees, and the seeds should be washed carefully to remove the adhering pulp and juice. The seeds should then be wiped dry and spread out under shade to dry thoroughly. They should be sown in drills 9 inches apart in the rows with an interval of 3 inches between the seeds at a depth of 1 inch below the surface; the finger or a small stick may be used for making the holes. After sowing, the seed-beds should be kept free from weeds and should be watered every other day in dry

weather. An excessive degree of moisture must be avoided. The seeds will germinate in three or four weeks and the seedlings will be ready for transplanting in nine to ten months from date of sowing of seed.

PREPARATION OF THE FIELD.

The field should be well ploughed and cross-ploughed to a depth of 8 to 9 inches after all stumps and roots have been thoroughly cleared. The clods turned out by the plough should be broken and a fine deep tilth should be prepared.

PLANTING DISTANCES.

The distances at which limes should be grown vary according to the position and texture of the land. Observations of well-developed trees at the Experiment Station show that a spacing of 15 by 15 feet is to be advocated. On poor soils and on steep hill-sides closer distances may be adopted. Holes should be at least 1 foot wide and 1½ feet deep. They should be dug about a month before planting and left exposed. Before planting is done, each hole should be filled with good surface soil and a basketful of well-decomposed farmyard manure thoroughly mixed together and pressed down in the hole.

TRANSPLANTING.

Great care is necessary in taking seedlings from the nursery beds. At the time of uprooting the seedlings the nursery beds should be thoroughly saturated with water as a wet condition of the soil helps the roots to carry as much earth as possible and also allows easy removal of the seedlings with the least injury to their roots. If practicable, showery weather should be chosen for transplanting. The plants should be taken up with all their roots for which purpose a fork is most useful. In use the fork should be pressed vertically into the soil to its maximum depth and then pressed over on one side.

PLANTING-OUT.

The commencement of the north-east monsoon is the best time for planting. It should be done preferably in the evening but a cloudy day can be utilised for the operation. An opening should be made with an alavangu or a wooden peg in the centre of the hole sufficiently deep and broad to admit the plants with their roots extended at full length and in a natural position, and care should be taken to see that the nursery level of the plant is maintained. The soil should then be tightly pressed round the plant with the hands and feet.

AFTER-CULTIVATION.

The lime is an exceedingly hardy plant and needs no protection from the sun at any stage of its growth. After the plants are well established the land should be kept clear of weeds and the

surface constantly stirred to minimise the loss of soil water by evaporation. Mulching by surface-cultivation should therefore be regularly carried on. Maniocs, maize, sorghum or chillies may be sown between the rows of lime plants as catch crops. On poor lands a leguminous crop such as green gram or ground-nuts may be sown. Mature limes are not usually clean-weeded. Circles round the plants are kept clean, while the remainder of the field is occasionally disc-harrowed. Under favourable conditions the lime may commence to give a few fruits in the third year after planting, but eight to ten years is the time necessary to bring a lime plantation into full bearing.

CULTIVATION AND FRUITING AT THE EXPERIMENT STATION, ANURADHAPURA.

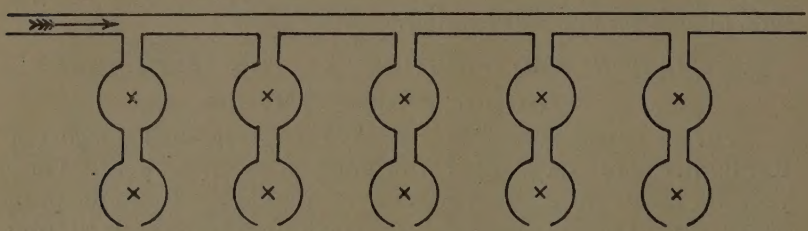
An area of six acres was cleared of jungle in 1918 at a cost of Rs. 35 per acre and planted with limes in the same year. One-year old plants raised from seed of old trees in the Anuradhapura district and of plants raised in Peradeniya from seed received from British Guiana were planted in rows 15 by 15 feet, giving 193 plants to the acre. Castor was sown as a catch crop in 1919 and dhall and green gram in 1920. In 1921 the plants were forked round in rings and mulched with jungle stuff. The dhall planted in 1920 was uprooted and the land was clean-weeded.

The first six rows of the trees along the main road to Jaffna were manured with farmyard manure in trenches cut round the plants in the year 1923. In the same year sunn hemp was sown round the young plants in basins. Regular cultivation by ploughing between the rows and disc-harrowing was started in November, 1923 and has been continued to date. In 1924 the area which had had farmyard manure was sown with *Crotalaria usaramoensis* and the rest with sunn hemp, which was ploughed into the soil at a later date. In the same year the lower branches of half of the trees which trailed on the ground were pruned and removed to facilitate weeding, cultivation and collection of fruits. In 1925 the plants which had a sickly yellow appearance were manured with bone meal at the rate of 2 lb. per tree. The manure was sprinkled round the plants and lightly forked in.

The Planet Junior cultivator is now being worked between the rows of limes instead of the disc-harrow. The latter is unsuitable as it banks up the earth around the plants and leaves drains in the rows.

A poor crop was obtained in 1926-27. It was largely due to a severe drought which caused the young fruit to fall before maturing. Irrigation was impossible owing to scarcity of water.

Irrigation was practised at other times. The method adopted was as follows. A trench about 1 foot wide and 4 inches deep was laid off parallel to the rows of the trees. A shallow hole was excavated round the base of each tree and the basins so made were connected with each other and with the long trench by short trenches between the trees. The basins could be cut off from the water supply by earth fillets. The following diagram shows the arrangement.



The number of vacancies supplied during the early stages is indicated by the fact that in 1926, eight years after the original planting, only 798 trees were in bearing out of a total of 1,158 trees.

Date.		No. of trees in bearing.		Average yield of fruits per tree.
1921-22	...	90	...	206
1922-23	...	155	...	308
1923-24	...	603	...	279
1924-25	...	702	...	484
1925-26	...	798	...	301
1926-27	...	755	...	164

The first crop was produced in 1921. There has been no difficulty in disposing of the fruit in the market at Anuradhapura. Traders from Jaffna, Trincomalie and Colombo have purchased large supplies at Rs. 10 per 1,000 delivered at the store of the Experiment Station. The principal fruit season is from August to November. Smaller crops have been obtained throughout the year.

Table A gives details of expenditure to date, table B gives details of yields, and table C of receipts from sales of fruit.

Table A.

Lime area = 6 acres; planted November, 1918.

Costs.

Period Oct. — Sep.	Planting & supplying vacancies.	Weeding	Cultivation, ploughing and disc-harrowing	Harvesting	Pruning	Irrigating	Stumping	TOTAL Rs.	TOTAL cts.
1918—19	—	—	—	—				515	95
1919—20	38·99	654·25	—	—	—	—	—	693	24
1920—21	150·56	450·54	—	86·29	—	—	—	687	39
1921—22	132·18	1,179·80*	—	26·45	·90	—	—	1,339	33
1922—23	16·82	1,567·11*	—	—	133·68	455·76	56·96	2,230	33
1923—24	—	649·12	—	—	5·85	44·60	—	699	57
1924—25	—	253·87	47·34	86·18	53·84	93·85	—	535	08
1925—26	—	146·09	66·15	252·44	—	15·92	22·09	502	69
1926—27	24·86	234·69†	133·04	81·14	—	13·41	18·39	505	53

Jungle clearing at Rs. 35/- per acre	210	00
Rs.	7,919	11

* This heavy expenditure was incurred in a study of the effect of clean weeding. As a result of the experiments an economical system of ploughing and weeding with implements was evolved.

† Includes levelling earth banked round the trees by the disc-harrow.

Table B.

Lime area = 6 acres; planted November, 1918.

Yields.

Month	1921-22	1922-23	1923-24	1924-25	1925-26	1926-27
October	—	412	4,545	14,309	18,425	4,813
November	—	4,627	8,856	20,080	11,617	14,549
December	1,773	5,723	7,315	38,660	15,954	36,054
January	2,574	1,253	7,054	49,505	13,590	7,825
February	1,965	113	1,646	11,605	12,118	4,310
March	1,895	—	10,640	17,940	14,900	20,662
April	320	625	6,210	11,145	41,135	9,179
May	3,500	1,025	1,475	10,248	10,085	1,884
June	6,100	2,997	3,195	7,250	6,250	1,565
July	325	6,502	14,309	43,396	38,803	7,860
August	50	6,339	29,774	60,582	34,772	9,872
September	50	15,125	73,012	55,380	22,940	4,965
TOTAL	18,552	47,741	168,031	340,100	240,589	123,538

Table C.

Actual receipts from sale of limes.

Year	October Rs. cts.	November Rs. cts.	December Rs. cts.	January Rs. cts.	February Rs. cts.	March Rs. cts.	April Rs. cts.	May Rs. cts.	June Rs. cts.	July Rs. cts.	August Rs. cts.	Sept. Rs. cts.	Total Rs. cts.
1920—21	1·25	—	—	—	—	—	—	—	—	—	0·50	2·50	4·25
1921—22	0·50	10·00	2·37	0·37	1·85	25·75	—	13·61	40·43	—	10·13	—	105·01
1922—23	1·00	19·64	37·09	1·25	1·35	1·57	7·15	6·75	11·59	63·70	31·15	105·71	287·89
1923—24	31·39	60·97	53·96	56·72	13·64	89·56	37·55	1·50	9·15	64·75	126·82	271·73	817·74
1924—25	85·55	164·63	234·57	344·34	85·73	131·71	82·13	45·38	67·20	81·04	185·44	380·01	1887·73
1925—26	143·65	91·12	113·69	80·40	74·86	106·02	266·84	102·64	42·88	155·96	177·61	85·19	1440·86
1926—27	33·67	115·74	329·46	70·61	71·35	128·09	48·23	23·46	19·73	66·01	69·25	61·81	1037·41
													5580·89

Picked limes were sold at 75 cts. to Rs. 1/50 per 100 and dropped limes at 25 cts. to 60 cts. per 100. Selected fruits were used for seed purposes and are not included in the above table.

DISEASES.

Citrus canker (*Pseudomonas citri*) was found to be present in 1922, principally on the leaves, but one plant was seriously attacked on the branches. The latter became covered with rough warts and ultimately died back. The plant was dug up and burnt and the rest of the affected plants were sprayed. Pink disease (*Corticium salmonicolor*) also appeared but was soon brought under control.

In July 1925, a tree was found to be affected by *gummosis* and amputation of diseased branches and tarring of wounds were carried out. In June, 1926, several trees were dying back with appearance of the disease known as *wither-tip*. The wither-tip fungus, however, was not isolated from the diseased material. A bacterium which occurred upon affected twings was tested in infection experiments with negative results. It was subsequently found that the trees were attacked by root disease caused by *Rhizoctonia bataticola*, a disease which is common among citrus in Ceylon. Forty one trees died out in 1926-27 and other twenty four are affected. The symptoms of the root disease are the gum mosis and dieback already mentioned.

SELECTED ARTICLES.

COVER CROPS AND GREEN MANURES.*

ONE of the most important problems which have to be dealt with by Malayan agriculturists is undoubtedly that of soil erosion and it is satisfactory to record that the employment of cover crops on both rubber and coconut estates throughout Malaya is now receiving much greater attention than formerly. This clearly indicates that the majority of planters are beginning to appreciate the numerous advantages which may be gained by growing one or other of the more suitable types of cover plants, both as a means of maintaining the fertility of rich soils and improving poor soils.

The necessity for taking every possible precaution to prevent the loss of valuable surface soil on either hilly or undulating land cannot be too strongly emphasised, since any neglect in this connection must eventually result in a serious loss in crop production and may even do so much permanent damage as to render the cultivation of a crop unremunerative.

The cultivation of one or more of the low-growing types of cover plants in combination with silt-pitting is one of the most satisfactory means of dealing with this particular problem.

The question of soil improvement, however, is an entirely different problem and generally consists in growing one of the erect types of cover plants with the object of digging the fresh prunings or, in some cases, the whole plant into the soil, thus enriching the latter by the addition of large quantities of organic matter. When a cover plant is grown solely for this purpose it is generally referred to as a green manure crop.

Green manure crops may to a certain extent serve as cover crops, and vice versa, but the erect types are naturally much less effective than the low-growing types for the purpose of arresting soil erosion on hilly or undulating land.

USES OF COVER CROPS.

The principal benefits which are derived from the cultivation of cover plants may be briefly described as follows :—

(1) The prevention of loss of surface soil on both undulating and hilly land liable to wash.

(2) The reduction of weeding costs, especially on newly-opened areas.

(3) The addition of humus to the soil by falling leaves and decaying stems.

(4) The aeration of the soil is improved by the roots of the cover plants tending to open up the soil and make it more friable.

(5) The protection of the soil and of the roots of crops from the excessive heat of the sun.

(6) The conservation of the fertility of the soil by taking up available plant food which might otherwise be washed away.

* By B. Bunting and J. N. Milsum in *The Malayan Agricultural Journal*. Vol. XVI. No. 7, July, 1928.

(7) The appropriation of additional nitrogen from the atmosphere in the case of leguminous plants.

The question of nitrogen fixation by leguminous plants by means of the nodules on their roots is probably of much less importance than the beneficial effect of decaying plant residues added to the soil by periodically turning the cover plant into the land, more particularly so in the case of soil deficient in organic matter. The probable reason for this is that the acid nature of most tropical soils is not so favourable for nitrogen fixation as that of soils in temperate regions. Investigations on this point are in progress at the Department.

Further, it is frequently asserted that cover plants by covering up the ground check the loss of soil moisture by evaporation. This is an entirely erroneous idea and may possibly have originated from the fact that the surface of the soil beneath a low-growing cover crop is always moist, owing to the fact that the cover plant prevents the drying of the surface layer of soil by evaporation. Such a condition, however, is purely artificial and it is now well recognised by scientific workers that a leafy crop is capable of evaporating three or four times as much water as the bare surface of soil on land lying under fallow, since the roots of the cover crop absorb an excess of water from below. This phenomenon is naturally not of such great importance in countries with a plentiful and regularly distributed rainfall as in those which are liable to long periods of drought.

OBJECTIONS TO COVER CROPS.

It might be mentioned that there are several objections to the use of certain cover crops such as (a) twining plants damaging the permanent crop (most twiners), (b) the risk or fire (*Mimosa invisa*), (c) the danger of harbouring diseases (*Tephrosia* spp.), and (d) the danger of harbouring insects (*Mimosa invisa*), and these factors must always be taken into consideration when selecting a cover plant.

SELECTION OF A COVER PLANT.

The essential characteristics of a good cover plant may be described as follows :—

(1) A perennial plant is always to be preferred to an annual on account of its greater permanency.

(2) A plant with a creeping habit, which will creep out to open spaces and root at the nodes, is preferable to the erect type that does not spread.

(3) A plant with a twining habit, which will entwine itself round even the thinnest shoots of grass and weeds, thus smothering them out.

(4) It should have a fairly well developed root system, so that its fibrous roots will assist in binding the surface soil together as much as possible.

(5) It should be a plant which makes rapid growth, so that it will soon form an effective cover.

(6) Plants which are easily raised from seed are usually to be preferred to those which can only be propagated from cuttings.

(7) Those which grow best in the open are the most suitable for young clearings.

(8) Those which grow best under shade are more suitable for mature areas of rubber or coconuts.

(9) It should not be subject to either diseases or pests liable to cause damage to the permanent crop.

(10) A leguminous plant is preferable to a non-leguminous one.

METHODS OF PLANTING.

It is most important that the cover plant should be planted as soon as possible after the land has been opened up so that the cover may become well established before any of the surface soil is lost, and while the land is free from weeds.

The method of planting depends on whether the plant is propagated from seed or cuttings, but the first essential is to see that the area to be planted is cleaned up and free from weeds.

When the cover is propagated from seed it is usual to sow the seeds in rows from 2 to 5 feet apart, the distance varying according to the habit of the plant. By this means it is possible to give more attention to weeding until the cover plant has completely covered the ground. The amount of seed required to plant up a definite area naturally varies with different types of cover plants and depends principally upon the distance of planting and on the size of the seed, the small-seeded types usually having a lower seed rate than the large-seeded ones.

Before planting the seed, the rows are lightly forked or changkolled and a quantity of good surface soil is placed in the rows to form a slight mound. The seed is then distributed on the loose surface, covered with a thin layer of soil and pressed well down in order to attract sufficient moisture from below to cause germination.

As a rule the seed of most cover plants germinates fairly rapidly without any treatment, but in the case of those types having a hard seed coat, which retards germination, it is sometimes advisable to place the seed in water heated to a temperature of about 45°C., where it should remain for a period of about 24 hours. Seed which has been treated in this way should on no account be allowed to get dry before sowing.

When it is necessary to propagate the plant from cuttings, the latter may be spaced roughly at distances of 2 or 3 feet apart or they may be placed in rows as in the case of planting from seed. Whichever system is adopted, great care should be taken to see that only mature cuttings are used and that when planted they are pressed well down; otherwise they may dry out.

In order to ensure success, planting operations should only be carried out at the beginning of one or other of the recognised wet seasons. Further, on soils where a certain amount of erosion has already taken place the addition of a small quantity of artificial manure may materially assist in establishing the cover plant.

Once the cover plant is established it should be kept some distance away from the main crop, particularly while the latter is in the early stages of development; otherwise there will be serious competition between the two crops for both water and plant food.

After planting, it is absolutely necessary to pay special attention to weeding until the young plants have formed an effective cover. Even then periodical weeding should be carried out systematically, if noxious weeds are to be kept under control.

It should be stated that, for some reason not understood, several of the cover plants described in this article are very shy seeders in Malaya, but fortunately they can all be propagated from cuttings, provided suitable weather conditions are selected for transplanting. Seed of such cover plants, although somewhat expensive, can invariably be obtained from Java and Sumatra in order to form a nursery from which future supplies of planting materials, in the form of cuttings, can be obtained.

DIFFERENT TYPES OF COVER PLANTS.

There are a large number of different species of cover plants at present under cultivation in this country and for practical purposes they may be divided into two distinct groups as follows :—

(a) Low-growing types more suitable for the prevention of soil wash.

(b) Erect-growing types more suitable for green-manuring.

Although the Department has from time to time had over fifty different species of cover plants under trial, principally at the Government Experimental Plantations, Kuala Lumpur and Serdang, only the more important ones are described in this article.

(A). LOW-GROWING TYPES SUITABLE AS COVER CROPS.

The low-growing or creeping types of cover plants are generally cultivated for the purpose of protecting the surface soil from wash and the roots of crops from the excessive heat of the sun and when such plants are used primarily for this purpose they are known as cover crops.

In this connection the following six cover plants have been selected as representative of the group in question and a few details as to their origin and methods of cultivation, together with their suitability under different conditions, are given below :—

(1) *Calopogonium mucunoides* (N. O. *Leguminosae.*)
(2) *Centrosema pubescens* (N. O. *Leguminosae*).
(3) *Dolichos Hosei* (N. O. *Leguminosae*).
(4) *Indigofera endecaphylla* (N. O. *Leguminosae*).
(5) *Pueraria phaseoloides* (N. O. *Leguminosae*).
(6) *Mikania scandens* (N.O. *Compositae.*)

CALOPOGONIUM MUCUNOIDES.

Description.—A vigorous creeping herb forming a mat of foliage, one to two feet high. The tendrils have a twining tendency, climbing in an anti-clockwise direction. Length of stems 3 to 10 feet, forming roots adjacent to each node. Stems succulent and entirely covered with short brown hairs. Leaves trifoliate, leaflets 1 to 4 inches long, 1 to 4 inches broad, hairy on both sides, oval with round or wedge-shaped base and blunt apex, having a small nerve point. The stipules are small and triangular. Flowers in racemes 1 to 4·5 inches long, flowers small, pale blue, from 4 to 12 on a raceme. Pod 0·75 to 1 inch long, about 0·2 inches broad, densely covered with brown hairs, containing 4 to 8 seeds. Seeds small, flattened and brown in colour, about 2·12 inches long and 0·1 inch broad. The number of seeds per pound is about 34,000.

Habitat.—The plant is a native of tropical America, but was discovered recently growing wild on the East Coast of Sumatra and in various parts of Java. This legume was introduced into Malaya about four years ago and its value as a cover plant was soon recognised .

Soil Conditions.—*Calopogonium* will thrive on a wide range of soils, but attains its maximum growth on newly-opened land which is well drained. Although it is a moisture-loving plant and on this account suitable for employment in ravines and other damp places, this cover cannot withstand stagnant water around its roots.

Good results are obtained on undulating land, recently silt-pitted or bunded, by sowing the seeds in lines on the "spoil" thrown out from the pits or from the sides of the bunds.

Propagation.—The most satisfactory method of establishing this cover plant is by sowing the seeds fairly thickly in rows from 3 to 5 feet apart according to the fertility of the land. The soil in the rows should be lightly forked or changkolled and, if the land has previously suffered from wash, any loose surface soil or wood-ashes from burnt timber may be added so as to form a suitable medium for establishing the plant.

Under ordinary conditions, if planted in rows 3 feet apart, about 5 lbs. of seed is required to plant up an acre, but where the soil is poor the seed rate may be increased to about 8 lb. per acre. On exceptionally rich land, where the rows are spaced 5 feet apart, 3 to 4 lb. of seed per acre will be sufficient. After the seed is sown in the rows it should be lightly covered with fine soil and well pressed down in order to maintain a sufficient supply of moisture near the surface.

Seed may also be broadcast on land which has been previously forked or changkolled, but this system has many disadvantages and is not recommended. Another method which is sometimes adopted is to dibble the seed into the soil at distances of about 3 feet apart each way. This is more economical as regards the quantity of seed required per acre but presents difficulties with regard to weeding until the plants have become established.

The plant may also be successfully propagated from cuttings but this method is not usually practised, since in planting out in the field a large percentage of failures occurs owing to drying out of the succulent cuttings.

Although the seed may be sown at practically any period of the year the best time for planting appears to be at the commencement of the wet seasons, March/April and September/October. It is most important that land should be in a friable condition and free from weeds when germination takes place, otherwise the young plants will be retarded in growth and weeding costs will be considerably increased.

Under average conditions the seeds commence to germinate within about 5 days from sowing and in about 4 months the growth of the plants is sufficient to cover the land.

As the plants develop the twining shoots spread outwards and the new shoots become attached to the soil by means of the roots thrown out at the nodes.

Flowering usually commences after 3 months from sowing and 3 months later the seeds are produced. *Calopogonium* is a very profuse seeder and natural reproduction takes place freely where there is sufficient space for the seedlings to thrive, more especially if the whole plant is dug under as a green manure.

On flat land where the growth of the cover has become very dense, it is frequently a matter of considerable difficulty to harvest seed in any quantity. The collection of seed is facilitated if there is any timber on the land over which the plants can climb.

General.—The plant is a perennial and when once established is of a fairly permanent nature, but during very dry seasons the older plants have a tendency to die off, thus leaving open spaces on the land. Natural regeneration, however, usually results in the land becoming recovered with a fresh supply of seedlings.

As previously stated, this plant has a twining habit and it is therefore necessary, particularly in young clearings, to prevent any climbing plants from damaging the permanent crop.

Although it is frequently stated that *Calopogonium* grows well under the dense shade of mature rubber this has not been observed in Malaya, where under such conditions the plants usually show weak growth and in

time tend to die out. The value of this plant lies in its employment as a soil cover and wash preventive in newly-opened areas and for these purposes *Calopogonium* is probably superior to most cover plants at present cultivated in this country.

CENTROSEMA PUBESCENS.

Description.—A twining herb ascending any supports with which it comes in contact, but on open land forming a loose mat about 18 inches deep. Stems hairy and inclined to be somewhat wiry. Leaves 4·5 inches long, petiole 1·5 to 2 inches long, trifoliate. Leaflets 1·5 to 2 inches long and 1 inch broad. Stipules minute. Racemes 1·5 inches long, 3 to 5 flowers on short stems 0·75 inch long. Flowers pale mauve with purple lines in the centre. Pod 4 inches long and 0·2 inches broad containing 12 to 15 seeds. Seeds 0·20 to 0·25 inches long and 0·12 inch broad, brownish-green with streaked and mottled dark-green markings, somewhat flattened. The number of seeds per pound is about 16,000.

Habitat.—This plant is stated to have originated in South America, but in 1921 was discovered growing wild in a few places in Java. It has been extensively cutivated as a cover plant in the Netherlands East Indies and to a smaller extent in this counrty.

Soil Contitions.—Centrosema pubescens requirs a fairly good soil and consequently some difficulty is usually experienced in establishing this plant. Further, like the allied species *C. Plumieri*, it will not grow under wet soil conditions.

Although at first comparatively slow growth is made, once the plant becomes established it forms an excellent cover and in 5 or 6 months the ground is completely covered with a mass of dense foliage.

Propagation.—As in the case of *Calopogonium*, the most satisfactory means of establishing this cover is to sow the seed in rows 3 feet apart, but since the seed is comparatively large it is not sown so thickly, only about 5 lb. of seed being required to plant up an acre. If, however, the seed is dibbled in at distances of 3 feet apart in the rows, allowing two or three seeds to a hole, about 1 lb. of seed will be sufficient for an acre.

The land having been cleaned of weeds and the rows lightly forked, in order to bring the soil to a friable condition, the seeds should be sown about half an inch deep and the soil highly pressed down on top.

Germination usually takes place within 10 to 14 days from time of sowing, but the growth of seedlings is at first somewhat slow and it takes at least 5 to 6 months before the plant forms an effective cover.

At this stage the plant begins to throw out a large number of twining stems, which are able to curve round even the thinnest shoots of grass and weeds, the latter being bent down by the increased weight of the young stems when forming leaves. Consequently this cover plant has a marked habit of choking out all other plants under its heavy foliage.

As the twining stems assume an upright position they do not form too compact a mass, thus allowing air to penetrate into the soil.

When the stems come in contact with the soil they produce roots from below the leaf stalks and therefore assist materially in maintaining vigorous growth, as in the case of *Calopogonium*.

The plant usually commences to flower about nine months from time of sowing and seeding follows about three months later. In order to encourage the production of seed the plants should be allowed to climb supports prior to the commencement of the dry season.

General.—A marked characteristic of *Centrosema pubescens* is its ability to withstand severe drought, the density of foliage remaining unchanged even during the driest weather.

As in the case of the majority of other cover plants this species is difficult to establish under heavy shade, but in those cases where it is firmly established before the shade is produced it continues to show fair growth under the altered conditions for some considerable time.

Undoubtedly this plant forms a very satisfactory cover crop under the light shade produced by coconuts and oil palm. Further, in new clearings, provided the soil conditions are suitable and the plant becomes well established, *Centrosema pubescens* is equal to, if not better than, *Calopogonium.*

Centrosema pubescens forms a much denser and more permanent form of cover than *C. Plumieri* and is far superior to the latter from every point of view.

DOLICHOS HOSEI.

Description.—A low, creeping perennial herb. Leaves trifoliate and slightly hairy, leaflets 1·5 inches long, stipules small and narrow. Stems wiry. Flowering racemes produced from the axils of the leaves on a stalk 1 to 2 inches in length. Flowers 3 to 4 in number, 0·25 inch long and pale yellow with orange keel. Pods about 0·7 inch long, few seeded. The seed is 0·2 inch long and 0·15 inch broad, colour brown, blotched chocolate. The number of seeds per pound is about 18,000.

This legume, referred to in the Netherlands East Indies under the synonyms of *Vigna oligosperma* and *Vigna Hosei,* should according to a recent determination by the authorities at Kew be known by the name of *Dolichos Hosei,* as originally described by Prof. Craib in the *Kew Bulletin of Miscellaneous Information,* No. 2 of 1914.

Habitat.—This plant is recorded as being indigenous to Sarawak, from where it was introduced to this country by the Department of Agriculture, Federated Malay States, as far back as 1913, under the name of the Sarawak bean, vide *Agricultural Bulletin, F. M. S.*, Vol. 1, p. 276.

About 5 to 6 years ago considerable interest was taken in this plant, under the name of *Vigna oligosperma,* as a cover crop for mature rubber areas.

Soil Conditions.—The Sarawak bean grows vigorously on a loose porous soil, especially where a mulch has been allowed to accumulate. It makes equally good growth on the lighter types of alluvial clay soils in the coastal districts provided that the land is not liable to flooding, but it is difficult to establish on the heavier types of clay or on hilly land which has suffered from surface wash.

Propagation.—The plant may be propagated either by seed or cuttings, but owing to the paucity and expense of seed it is in the first instance advisable to establish the plants in nursery beds. Once these beds have become established a plentiful supply of cuttings will be available for transferring to the field.

When the seed is sown in nursery beds the soil should be cleaned of weeds and lightly forked to form a good tilth. The seeds are then sown about half an inch deep at distances of 9 to 12 inches at the rate of two seeds per hole, which is equivalent to about 5 lb. of seed per acre. Under normal conditions the seeds will germinate in about ten days from sowing and all that is necessary is periodical weeding while the plants are young.

Within about three months the nursery beds should be entirely covered by the plants and a commencement may then be made to take cuttings for planting out in the field. The older the cuttings the better they will stand transplanting. In taking cuttings, portions of the stem about 1 foot long, with three internodes, should be selected.

On young clearings the cuttings may be planted in the field in rows 3 feet apart and about 2 feet in the rows, requiring approximately eight sacks of cuttings to plant up one acre.

An alternative method for mature rubber areas is to make holes a changkol deep in rows about 6 feet apart, the holes being spaced 3 feet apart in the rows. A small quantity of cattle manure is mixed with the soil removed from the hole; two cuttings are then laid crosswise on the surface and the loose earth replaced, the cuttings being firmly pressed into the soil with two internodes below the surface.

With rubber planted at distances of 20 feet by 20 feet apart, the planting of two or three rows of Sarawak bean between each row of trees will cost from $2·50 to $3 per acre. This cost includes the collection and preparation of cuttings, supply of cattle manure and planting.

In suitable weather the growth is rapid and the land will be well covered to a depth of 4 to 6 inches within a period of six months.

After the cuttings have been removed from the nursery beds a new flush of growth will take place with the result that further cuttings will become available within about three months.

Although the plants flower fairly freely in this country, it is only rarely that seed is produced, and even then in such small quantities as to make its collection impracticable. Supplies of seeds, however, are obtainable in quantity from Sumatra, thus overcoming this difficutly.

General.—It should be stated that the plant has a very shallow rooting system compared with other cover plants and in view of this it is probably of greater use as a cover on flat and undulating land rather than for the prevention of surface wash on steep hilly land. It is a moisture-loving plant and appears to thrive best in low situations.

The Sarawak bean is specially valuable owing to the fact that it thrives well under the dense shade of old rubber areas, where most other cover plants usually fail.

During the rainy seasons, especially after heavy showers, the foliage sometimes dies off in small patches, but in such cases fresh growth is made with the advent of dry weather.

Owing to its prostrate habit, the plant has not that tendency to climb the trees exhibited by several of the more vigorous types of cover plants.

The plant is of a permanent nature and once it is established it will remain in a vigorous condition for a number of years, even under heavy shade.

INDIGOFERA ENDECAPHYLLA.

Description.—A low creeping herb. Leaves pinnate, with an odd terminal leaflet. Leaflets 7 to 13, side leaflets alternate, up to 1 inch long. Stipules narrow and membranous. Racemes up to 4 inches long, many flowered. Flowers in spikes, small, under 0·3 inch long, purple pink. Pod 0·75 to 1 inch long, four-sided, 6 to 10 seeded. Seed minute measuring 0·06 to 0·07 inch long, light brown in colour. The number of seeds per pound is about 220,000.

Habitat.—This plant is a native of Southern India, where it occurs at an elevation of 3,000 feet, though it is known to thrive well from sea level up to 6,000 feet.

It was originally employed on the tea plantations in Ceylon and South India from where it was introduced to the Netherland East Indies and Malaya.

Soil Conditions.—It thrives best on land which has not suffered from wash and appears to require a moist soil containing a fair amount of humus. It was formerly suggested as a possible cover plant for old rubber areas for use in a similar manner to the Sarawak bean, but it has not proved a success under such conditions in Malaya.

Propagation.—The plant may be raised readily from seed, but as the latter is somewhat difficult to obtain, it is, at least in this country, usually propagated from stem cuttings. The cuttings, which should be about 9 inches long, are dibbled into the land at distances of about 2 feet apart each way, approximately three sacks of cuttings being required to plant up one acre.

After about six months from planting, the cuttings form a low compact cover about 6 inches deep over the land.

Seed may be obtained from both Sumatra and Java, but, since it is somewhat expensive, seed should only be used for establishing small plots of this plant. Owing to the small size of the seed it should be mixed with sand previous to sowing, thus allowing for a better distribution. If planted in rows three feet apart, the seed rate will be about 3 lb. per acre.

The plants send out trailers, which under suitable conditions may attain a length of 5 feet, and these produce numerous adventitious roots, thus assisting the cover in becoming more firmly attached to the soil.

In the first instance the cuttings apread all over the land and growth remains very low, the cover rarely execeeding 4 inches in height. As the plants mature, they become somewhat taller and at two years old are usually about 12 inches high.

The plants flower within about one year from planting and the seed matures in a further three months' time.

General.—*Indigofera endecaphylla* is being used in South India and Ceylon as a cover plant with young rubber and has recently been extensively planted in the Netherland East Indies for this purpose.

The plant unfortunately has a tendency to die back in dry weather, but it puts out vigorous fresh growth at the commencement of the rains. It is also liable to attacks from the larvae of a small moth, probably *Lamprosema diemenalis,* but the damage is not permanent.

PUERARIA PHASEOLOIDES.

This plant is often referred to under the synonym of *Pueraria javanica.*

Description.—A strong twining herb attaining a length, in the wild state, of over 20 feet. Stems hairy. Leaves 6 to 8 inches long, 4 to 5 inches broad, trifoliate. Flowers in racemes, 12 inches long in scattered pairs, mauve in colour. Pod smooth, narrow and flat, 3·5 inches long and 0·2 inch wide. Seeds dark brown, 0·15 inch and 0·1 inch broad. The number of seeds per pound is about 37,000.

Habitat.—This plant which is distributed troughout Indo-Malaya, occurs occasionally on the plains in Malaya growing over low shrubs in open situations. Although indigenous in this country it has only comparatively recently been cultivated.

Soil Conditions.—This cover plant appears to be best suited to the heavier types of soil and will not thrive in dry sandy situations. It is specially adapted to the alluvial clay types of land found in the coastal districts and is likely to prove a valuable legume for use on coconut estates.

Propagation.—There is every indication that this plant is a shy seeder and for this reason seed is not only expensive but difficult to obtain. The plant, however, roots rapidly from cuttings and may be propagated by this means.

Stem cuttings, about 2 feet long, should be taken from mature shoots and planted at distances of about 3 feet apart each way on clean land. It requires approximately ten sacks of cuttings to plant up an acre. The cuttings root very readily and in about three or four months a very fair cover about 6 to 9 inches deep is formed.

Although growth is somewhat slow at first a thick dense cover is eventually formed.

General.—As previously mentioned, this cover plant has only recently received attention, but it thrives exceedingly well under shade and should be of considerable value on this account.

This cover plant has been recently observed growing under the dense shade of old rubber on a clayey type of soil where the Sarawak bean failed to become established. In this instance a system of selective weeding was previously adopted and resulted in the *Pueraria* entering the area, eventually forming a very effective cover.

MIKANIA SCANDENS.

Description.—A twining herb belonging to the Natural Order *Compositae*. Leaves opposite, 1 to 2 inches long. Flowers whitish, small and inconspicuous, produced in heads 2 inches wide. Seeds extremely minute and so light that it is almost impossible to collect them.

Habitat.—The plant is indigenous to Malaya, where it is commonly found twining over shrubs and low-growing trees on the edges of jungle up to an elevation of 4,000 feet.

It is known in this country under the following native names :– "Akar lupang", "Cheroma" and "Akar ulam tikus."

Soil Conditions.—This possible cover plant will grow successfully on almost any type of soil and is frequently met with as a weed on estates. Its advantage lies in the fact that it can often be established on comparatively poor soils on which other cover plants have failed.

Propagation.—Owing to the great difficutly in collecting seed the plant is always propagated from cuttings, which are taken from the mature stems. The cuttings should be about 1 foot in length and planted at distances of from 5 to 10 feet apart, requiring approximately one sack of cuttings per acre when planted at the former distance.

Providing the weather conditions are suitable, the rooted cuttings spread with extraordinary rapidity and within three to four months from planting the plants will have completely covered the land to a depth of about 1 foot. On account of its rapid growth it has been described as "the mile-a-minute plant".

General.—Owing to the twining nature of the plant all weed growth is entirely checked. If employed as a cover among crops which branch near the ground, care should be taken to prevent it climbing over the young plants.

The plant is capable of withstanding long periods of drought and will thrive well under light shade.

In view of its remarkably rapid growth and the very close mat of cover which it quickly forms over the surface of the ground, *Mikania scandens* will suppress all weeds, a factor to be considered when the reduction of weeding costs is one of the main objects. When the plant is cultivated on young clearings great care should be taken to keep it well away from the roots of the main crop; otherwise it may enter into serious competition with the latter for available supplies of plant food. Although *Mikania* is so strong growing it can be very easily eradicated at comparatively little cost, if desired.

This cover plant is a non-leguminus one and therefore has not the power attributed to leguminous plants of collecting nitrogen from the atmosphere, but its dense growth produces a large quantity of organic matter, which will prove useful in enriching soils deficient in humus.

MIXTURES OF COVER PLANTS.

Having described the merits of the respective cover plants when grown singly, attention should be drawn to the possible advantages of planting a combination of two or more cover plants.

In practice, it will be found that certain cover crops produce comparatively rapid growth at first, but gradually die off, while others which show somewhat slow growth at the commencement eventually produce a more permanent form of cover, thus taking the place of the less permanent one. An example of this is to be found in the case of a mixture of *Calopogonium mucunoides* with *Centrosema pubescens,* the latter gradually replacing the former. Further, plants such as *Calopogonium mucunoides* and *Centrosema pubescens,* which are not tolerant of dense shade, make excellent growth in the open, while such plants as *Pueraria phaseoloides* and *Dolichos Hosei* will thrive almost as well in the shade as in the open.

Excellent results have been obtained on young oil palm clearings with a mixture of *Calopogonium mucunoides, Centrosema pubescens* and *Pueraria phaseoloides.* In such a mixture the seeds of *Calopogonium mucunoides* and *Pueraria phaseoloides,* being about the same size, might be mixed together before sowing, but the larger-seeded *Centrosema pubescens* should be sown separately in order to ensure a more even distribution of the different cover plants comprising the mixture.

(B). ERECT-GROWING TYPES SUITABLE AS GREEN MANURES.

The erect-growing or bushy types of leguminous plants are cultivated principally for the purpose of providing large quantities of organic matter and when the plants are periodically cut back and the fresh prunings dug into the soil they are known as green manure crops.

When the green material is turned into the soil it not only increases the amount of humus, but in the process of decomposition has the effect of liberating the dormant mineral constituents of plant food, such as phosphoric acid and potash already present in the soil, and rendering them more readily available for the main crop.

Although there is a wide range of leguminous cover plants which can be employed for this purpose, details are given below of the origin and method of cultivation of the two more permanent types which have proved most satisfactory for cultivation in Malaya :—

(1) *Tephrosia candida* (N. O. *Leguminosae*).

(2) *Crotalaria anagyroides* (N. O. *Leguminosae.*)

TEPHROSIA CANDIDA.

Description.—A bushy erect shrub attaining a height of 8 to 10 feet. Stems branching and covered with short hairs. Leaves pinnate, about 6 inches long, leaflets 1·5 to 2 inches long, 0·5 inch broad, hairy on the underside only, oblong with a small nerve point at the apex. Stipules small, narrow. Flowers in racemes, 4 inches long, flowers large, 1 inch long, colour white, numerous on the raceme. Pod 3·6 inches long, 0·3 inch broad, hairy, narrow, 10 to 12-seeded. Seeds small, flattened, olive green in colour, about 0·2 inch long and 0·15 inch broad. The number of seeds per pound is about 26,000.

Habitat.—This shrub is a native of tropical Asia, and is commonly known by the name of "Boga medaloa". It has been a favourite green manure in India and Ceylon for many years and is also well known in Malaya. The plant is very robust and thrives well at all elevations from sea level up to about 5,000 feet.

Soil Conditions.—*Tephrosia candida* grows well on almost all types of soil, but is liable to die out prematurely on very dry land. It is well suited to the alluvial soils of the coast, where it forms dense growth. On inland soil, however, its habit is less vigorous and in exposed positions on poor land it dies out within three years, especially if pruned periodically.

Propagation.—As this plant is usually employed as a green manure amongst such crops as rubber, coconuts, oil palms, tea and coffee, it is obvious that the distance of sowing will vary according to the permanent crop. At the Government Plantation, Serdang, this green manure has been extensively used amongst a variety of crops. On an area of limes, planted 20 feet by 20 feet triangular, two rows were sown between the limes, requiring 5 lb. of seed per acre. On an area of oil palms, planted 28 feet by 28 feet triangular, seed of this legume was sown in rows of 3 feet apart there being seven rows between the rows of palms. From 9 to 10 lb. of seed were sown per acre in this instance. When used as a green manure amongst coffee, planted 10 feet by 10 feet apart, one row between the coffee was found sufficient. On open land, when sown thinly in rows 5 feet apart, about 6 to 7 lb. of seed are required per acre and under favourable conditions germination may be expected within about one week. The most suitable time for establishing this plant is at the commencement of the rainy period when the land is usually free from weeds.

Within about four months from sowing the seed, the plants average 3 to 5 feet high and begin to shade the land. The plants commence to flower at six months and, when in full bloom, they should be pruned to within 1½ feet from the ground. If pruned too low they are liable to die back. The plant is at all times very impatient of severe treatment. Pruning should not be undertaken during the dry seasons for this reason. Further pruning may be done as the plants increase in size, preferably when they commence again to flower freely. The reason for this is that in formation of seeds there is a heavy drain on the food meterials absorbed and manufactured by the plant. On average land the plants will live for four years or so and should be pruned at least twice a year.

General.—In most districts it is a difficult matter to collect seed of *Tephrosia candida*, though large quantities are formed. This is due to the depredations of a small Platyrrhinid beetle (*Araecerus fasciculatus*), which lays its eggs in the immature pods. The eggs hatch in the pods and the larvae feed on the seeds causing, in most instances, destruction of the entire contents of the pod.

A possible objection to the use of this legume on young rubber clearings is that on account of its woody habit of growth the plant is liable to harbour pink disease (*Corticium salmonicolor*), particularly if the development of the plant is not restricted by periodical pruning.

Tephrosia candida attains its maxium development in full sunshine, but will thrive well under light shade. This is specially so when grown with coconuts and oil palms. Under rubber, the plants rapidly weaken as the overhead shade increases. It is in much favour in Sumatra as a light shade and green manure for tea. When employed for this purpose the plants are grown as standards and allowed to spread out when about seven feet high so as to form overhead shade. When grown as a hedge plant between rows of young coffee it forms an excellent windscreen.

This legume is a valuable plant on account of the large amount of green matter added to the soil both from prunings and from decaying leaves. The leaves which continually fall from the plant during its growth take a long time to decay, so that they form an excellent soil cover, thereby restricting the growth of weeds.

Experiments were carried out at the Government Experimental Plantation, Serdang, with *Tephrosia candida* planted as a green manure on two one-acre plots of oil-palms. The first pruning was made at 6 months and two subsequent prunings at intervals of three months and on each occasion the plants were cut back to within about two feet from the ground. The result of this trial showed that the average yield of freshly cut prunings of *Tephrosia* per plot was 14,380 lb. during the first year of growth, *i.e.*, from the date of sowing the seed.

In another set of trials conducted at Serdang, with *Tephrosia candida* grown as a sole crop on a smaller area and under better soil conditions, the plants were cut back to within three feet of the ground at intervals of six, nine and twelve months respectively. The total yield of fresh prunings in this experiment was 26,880 lb., per acre during the first year of growth.

In order to obtain the full benefit of this plant, or any other green manure, the fresh prunings should be dug into the soil. When the operation is being performed a small quantity of air-slaked lime added to the soil will often give beneficial results.

Tephrosia candida is a robust plant which can withstand fairly frequent pruning and is therefore capable of adding large quantities of organic matter to the soil. These excellent qualities, combined with the fact that the plant is comparatively long-lived, make it one of the most suitable for use as a green manure.

CROTALARIA ANAGYROIDES.

Description.—A tall, bushy, erect shrub reaching a height of 12 to 14 feet. Stems woody at the base, branching above, covered with minute hairs. Leaves trifoliate, leaflets 3 to 3·5 inches long, 1·25 inches broad, slightly hairy on the undersides, smooth on the upper, oblong with a small nerve point at the apex. Stipules minute. Flowers in racemes, 10 to 12 inches long, flowers 0·75 inch long, colour pale yellow with a few black streaks on the standard, numerous on the raceme forming an oblong head. Pod 1·50 inches long, 0·60 inch broad, flattened with a point at the apex, covered with short pale hairs, containing about 16 seeds. Seeds flattened, 0·20 inch long, 0·15 inch broad, brown in colour. The number of seeds per pound is about 24,000.

Habitat.—This shrub is a native of Central and South America, and is of comparatively recent introduction to the East Indies. A supply of seed of this plant was obtained from the Department of Agriculture, Buitenzorg,

at the beginning of 1924 for trial at Serdang. The results of this trial showed that it thrives well in Malaya and is the most luxuriant of the shrubby leguminous cover plants so far introduced. Although the plant is more suited to the plains it can be grown successfully at elevations up to 5,000 feet above sea level.

Soil Conditions.—This plant grows well on the majority of soils, but makes most vigorous growth on sandy loams of a good depth. Where drainage is deficient growth is retarded and the plants gradually die out. It is particularly valuable on account of its deep-rooting habit, which assists materially in breaking up the lower layers of subsoil.

Propagation.—As in the case of *Tephrosia candida* the distance of sowing depends on the permanent crop under cultivation. On open land the seeds may be sown thinly in rows five feet apart, requiring 5 to 6 lb. of seed per acre. This plant is being used at the Experimental Plantation, Serdang, as a green manure amongst coffee, planted 10 feet by 10 feet square, one row of the legume being planted between each row of coffee.

The plant makes very rapid growth and attains a height of 6 feet at the end of three months, while flowering usually commences within a period of three to four months from germination of the seed. Pruning should be undertaken when the plants are in full bloom, but before the first pods begin to form and again as often as the plants become sufficiently dense, which may take from three to four months according to the season. Although this *Crotalaria* is frequently stated to be of superior constitution to *Tephrosia candida* it appears to die out more readily than the latter when the plants are heavily pruned.

General.—Though the seeds are often attacked by insect pests considerable quantities of sound seed are produced and there is usually no difficulty in securing a sufficient supply of seed in this country. The plant produces seed most abundantly when grown in full sunlight; consequently when seed production is the main object it should be planted on open land. Under such conditions, the plant will commence to produce seed within about six months from the time of sowing. After the plants have been allowed to seed freely for a period of about three to four months they should be cut back to within 2 feet from the ground, preferably at the beginning of a wet season. If this practice is followed a good supply of seed may be harvested from plants up to at least two years old.

Experiments were conducted at the Experimental Plantation, Serdang, with *Crotalaria anagyroides* planted as a green manure on two one-acre plots of oil palms. The first pruning was made at three months and three subsequent prunings at intervals of three months, on each occasion the plants being pruned back to within about 2 feet from the ground. The result of this trial showed that the average yield of fresh prunings was 27,156 lb. per plot during the first year of growth, *i.e.*, from the date of sowing the seed.

It is interesting to note that in this particular trial *Crotalaria anagyroides* was ready for pruning within a period of three months from sowing the seed, whereas the slower growing *Tephrosia candida* was not ready for pruning until six months old. On the other hand *Crotalaria* was beginning to suffer from the effects of the excessive pruning at the end of a year, while *Tephrosia* was still growing vigorously.

In further trials carried out at Serdang with *Crotalaria anagyroides* grown as a sole crop on a smaller area and under slightly better soil conditions, when the crop was cut back to within 3 feet from the ground at intervals of six, nine and twelve months respectively, the total yield of fresh prunings was 33,120 lb. per acre during the first year of growth.

Allowing for 75 per cent. of moisture in the fresh prunings the above yield would be equivalent to 8,280 lb. of dry matter per acre per annum.

The principal advantages of *Crotalaria anagyroides* are that it grows remarkably well under varying conditions of both soil and climate and can withstand comparatively long periods of drought. Further, it grows very rapidly and produces large quantities of organic matter, which when periodically dug into the ground not only serves to improve the physical condition of the soil but materially to increase its nitrogen content, thereby benefiting the permanent crop.

CONCLUSIONS.

Although the low-growing or creeping types of cover plants are cultivated primarily for the prevention of soil erosion, the additional advantages which may be derived from periodically digging such plants into the soil as a green manure should not be overlooked. The main object is, however, the first consideration, so that on steep land liable to soil wash only alternate strips of the cover plant should be treated for the purpose of green manuring. A few weeks later the areas so treated should either be replanted with the same or, better still, another species of cover plant.

The cultivation of the erect types of cover plants with the periodical digging of the prunings into the soil with the object of improving its fertility is an entirely different matter. By this means several tons of dry matter are added to the soil at each pruning, thereby increasing the amount of plant food in the soil and at the same time improving its physical condition by supplying large quantities of organic matter. In order to obtain the full advantage of a green manure crop it is essential that it should be pruned and dug into the ground when in full bloom and before the seed pods begin to form.

The seed rates as recommended in this article represent the minimum quantities which are required to plant up an acre when the shortage of seed necessitates a certain amount of economy in this connection, but, in cases where a plentiful supply of seed is available at a comparatively low cost, a cover will be formed more quickly by increasing the seed rate per acre.

Considerable difficulty is frequently experienced in establishing a cover plant under the dense shade of old rubber and this is generally due to the fact that the surface feeding roots of the rubber trees are in serious competition with the young cover plant for available supplies of plant food. This difficulty can sometimes be overcome by the addition of small quantities of either cattle manure or artificial fertilizers at the time of planting.

It should be pointed out that it is quite impossible to make any definite recommendations as to the most suitable cover plant for the varying conditions of types of soil which are to be found on different estates. What will suit one particular estate may not suit another; consequently the selection of a cover plant is a matter which can only be decided by establishing small experimental areas of the more promising cover plants on the individual estate.

SOME CONSIDERATIONS ON SILT-PITTING.*

CONSIDERED as a planting topic the subject of silt-pitting is marked by the number of points it presents which have not yet got beyond the controversial stage. This is but the reflection of the fact that it is a comparatively short time since soil conservation work of this kind was introduced into rubber estate practice. So many variations are presented by the different soils and situations, and by the different ways in which silt-pitting may be devised, that it is little wonder that a settled practice does not immediately emerge. Even the limits under which the different schemes may be regarded as applicable have never been properly defined. Practices which have been found to work well under a given set of conditions may want examination and modification before equally good results may be expected under changed conditions. It is the purpose of this paper to deal with some of the more fundamental points which must be considered in evolving from the stage of conflicting opinion towards that of a standard practice, though much remains to be done before the details of such standards can be firmly laid down.

In some respects the term "silt-pit" as applied to most of the soil conservation work today is not too well chosen, although it has probably come to stay. It is apt to carry with it the idea of silt-collecting pits rather than that of silt-prevention pits. Silt being the product of soil erosion it is plain that an ideal system for preventing erosion will put silt out of the question. It is certainly the less of two evils to collect silt rather than to loose it, but it must be quite clear that to prevent any silt formation at all is the vital aim of all remedial measures.

This criticism does not bear the same weight in cases where the pitting may be regarded as a temporary expedient, and this question as to the permanency of the pits is one that we must deal with at the outset. The most natural way in which wash can be prevented is by the growth of low-growing cover. Where such is feasible silt-pitting may be introduced as a merely temporary measure to protect freshly cleared land until a cover can be established. In such a case it is not objectionable if the pits do fill up in a short time. But in the main we are speaking of systems which it is desired to maintain permanently. A good stand of rubber may be expected ultimately to carry such a heavy canopy of leaves that an adequate ground cover is likely to prove an impossibility on account of shading. In such a case earthworks must be relied on to stop wash, since a tree canopy is not of such a type as to simulate the protective action of a ground cover. We may say then that, although the ideal prevention of soil erosion is provided by the natural conditions of a ground cover, yet this must often be reinforced and sometimes replaced by a system of silt pits under the conditions which apply to rubber plantations.

The soil erosion with which we are dealing is that produced by excessive rainfall, excessive in its rate of fall rather than in total quantity over a long period of time. The eroding action is of two distinct kinds, one a disintegration produced by sheer impact of large drops and the other and more

* By W. B. Haines in the *Quarterly Journal* of the Rubber Research Institute of Malaya, Vol 1, Nos. 1 and 2, January, 1929.

important the wash produced by cumulative surface-flow of water. The first action is most noticeable where soil has been loosened, as on a bund, and gives rise to those little pillars of soil which one so often sees. Fitting exactly on top of each one will be found a stick, a leaf or some small object which has protected the soil immediately beneath it, while all round the soil has been cut away in the vertical line of impact of the falling drops. In other circumstances, as on a level clay soil, an opposite effect may be produced, the falling drops in that case puddling the soil surface by their impact and producing a state of unhealthy consolidation or deflocculation, as it is called.

The most important action that we have to combat, then, is the surface flow produced by rain falling at a rate in excess of that at which the soil can absorb it. The pit is a simple expedient to increase effectively the capacity of the soil to take up the water. Water movements in soil which govern the question of absorption take place as the result of a difference in pressure between two locations, and such difference may result from two quite distinct causes. In the first place there is the universal hydrostatic head produced by gravitation and secondly there is the effect of capillary suction. One tends to increase the pressure while the other decreases it, but both cause movement. In certain cases the capillary effect may be the largest factor producing water movement, and it may also act either in conjunction with or against the gravitational effect according to circumstances. Consider the course of events when rain falls upon a dry soil surface. At first it is quickly absorbed, mainly by capillary attraction, since the capillary suction is generally high for dry soil. As the saturated surface layer extends, however, the water front reaches moister soil and the capillary suction diminishes; also the resistance to water movement is proportional to the depth to be traversed, so that for two reasons the rate of water absorption rapidly diminishes as the depth of penetration increases. In addition to this there is a very important effect which comes in to bring water penetration to a standstill, and that is the trapping of air in the soil pores. It is self-evident that water can only enter the soil if the displaced air can escape, and this escape may be prevented if the rain is of such intensity as to saturate completely the surface layer of soil and leave no open pores. If the underlying layer contains much air, that is, is fairly dry, the water above sits on a pneumatic cushion, as it were, and cannot penetrate farther. In ordinary cultivation the practice of ridging helps to get over the difficulty, and in rubber estate practice there is little doubt that silt-pits also help by providing subterranean outlets for the displaced soil air. All such movements, of course, benefit the soil. The considerations apply to the rapidly changing conditions of a rain storm. The low water movement which goes on by which the soil drains under gravity is of equal importance because it is incessant. The soil holds a certain proportion of water by capillarity and the rest tends to drain always lower at a rate depending upon the openness of the soil texture. This continued subterranean flow is well evidenced by the way our rivers continue to be fed even after rainless periods.

A large part of the rainfall in Malaya is of that intense type which no soil, however porous, can keep pace with by absorption. In fig. 1 some of the rainfall records taken at the Rubber Research Institute are so presented as to show this characteristic. The values have been plotted to show the *rate* of rainfall at any given moment. Taking the curve in broken line we have an ordinary steady rain presented. The average rate of fall over several hours is about ¼ inch per hour and the greatest intensity reached is about 1 inch per hour. The total is 1½ inch and the period would be reckoned an exceptionally heavy rain in the temperate zone. Yet the comparison with

the curve in continuous line, which shows a more typical local downpour, is very striking. The rain comes in bursts which reach an intensity of 6 inches per hour. The last burst would certainly fall upon a soil already saturated and it represents over an inch of rain deposited in fifteen minutes. This alone would be one hundred tons of water per acre to work havoc by surface flow unless silt-pit accommodation is provided for it.

The great secondary advantage of silt-pitting is that the moisture is conserved as well as the soil. The sites which stand in greatest need of the one, namely hilly land, are also in greatest need of the other, since on a hill the trees are much less likely to be within reach of permanent ground waters than on the flat. Silt-pitting causes much greater quantities of water to percolate naturally into the soil of a hillside. In this way the trees not only get a more adequate moisture supply, but they may get a more extended root range which is of the greatest value. This is analogous to the beneficial effects of drainage on flat land. Although in the one case we are draining water into the soil while in the other case we are draining it out, yet the effect of water movement and consequent aeration is the same in replacing stagnant conditions with healthy ones. It is sometimes assumed that aeration is effected merely because a hole is dug and the soil exposed to the air, but this is by no means the important aspect of the case. Indeed, it is important to remember that added exposure means added evaporation, which has its disadvantages under certain circumstances.

In making the calculations necessary for scheming a system of silt-pitting the most difficult point to deal with is to decide what quantity of excess rain is normally to be dealt with. The term normally is used because it is probably impossible or at least uneconomic to devise the system to meet the very exceptional cases of excessive and continuous rain.

The pits must have a capacity to hold the excess water of a normal rain with an additional reserve to cover the contingency of further rain falling before the pits have had time to empty. The last factor becomes so great on some heavy soils owing to the extreme slowness of percolation, that it sets a very serious limit to the utility of pits on such sites. Thus we require data both as regards rainfall and as regards soil permeability before we have a basis for laying down a sound scheme. One method of roughly examining the data is shown in fig. 2. Along a line divided into intervals to represent days blocked in, columns are erected of heights to correspond to each days rain. The case shown is the most rainy period during a year's records at Kuala Lumpur. For the purpose of the examination we will suppose that it is proposed to dig pits to have a capacity of 2½" of rain, which would correspond to a system of pits 24" x 24" section placed continuously on contours about 19 feet apart. We will further suppose that percolation out of the pits is at the rate of 1" per day, so that full pits would take 2½ days to empty. Most soils on hill sites would take less time than this, but it must be remembered that the rate will fluctuate greatly according to the degree of soil and subsoil saturation. Imagine now that the height of the columns represents the degree to which the pits are filled each day. Starting at the first day we allow a small proportion of rain taken up by the soil and draw a sloping line at the requisite angle to show the rate at which the pit will empty. The amount cut off by this line on the next column may be taken as the amount of water left in the pit when the second day's rain falls and the column is extended by this amount. This procedure is carried on, so giving a rough idea of the state of the pits at any time during the rainy period. When the extended column rises higher than 2½", this indicates overflow and consequent damage due to inadequacy of pits. It will be seen that this occurs on the second day and the three

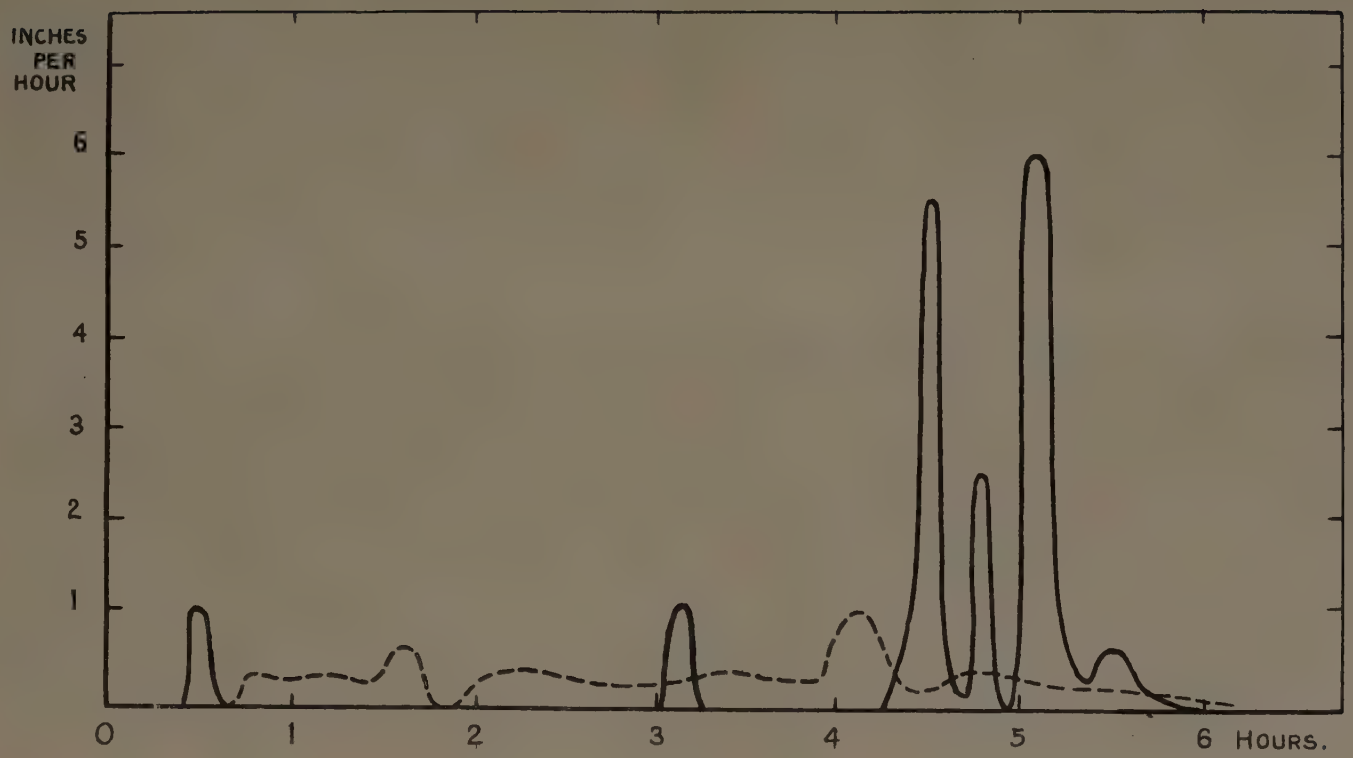
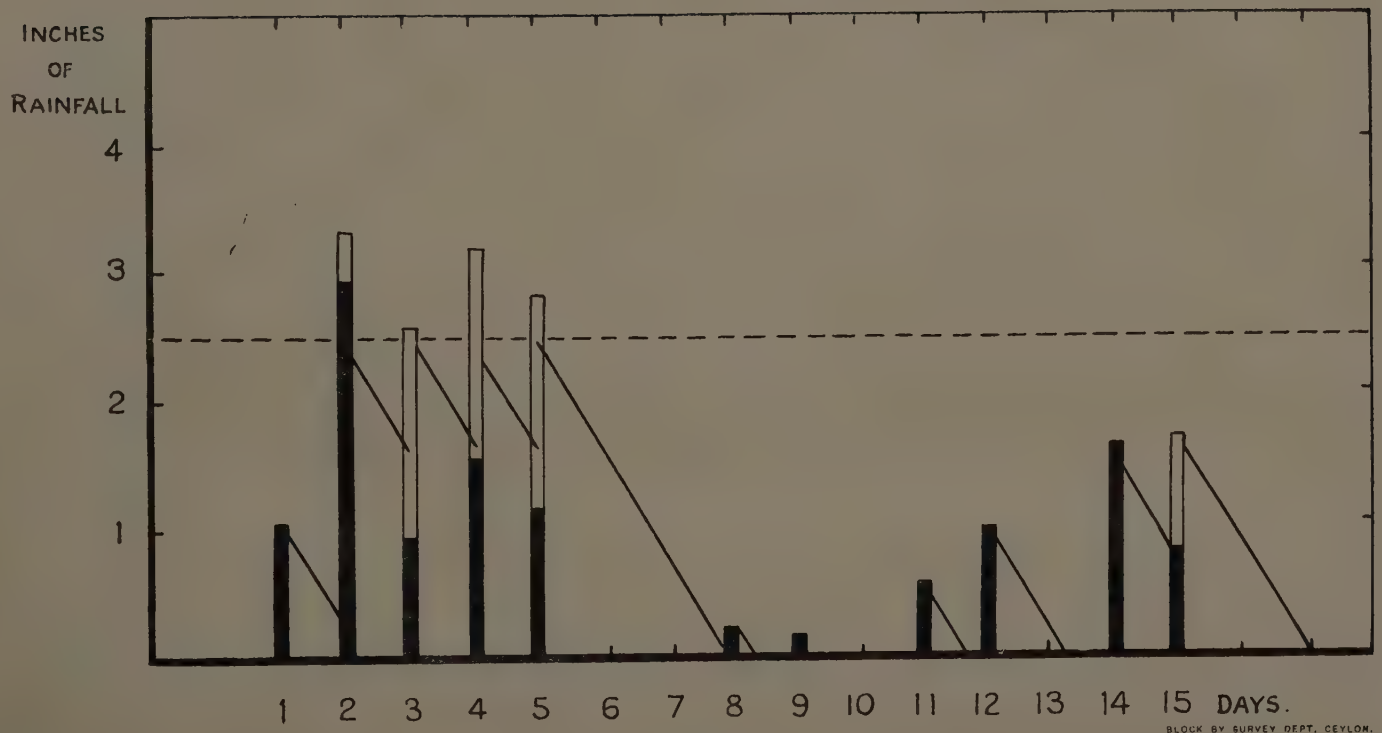


FIG. 1.

BLOCK BY SURVEY DEPT. CEYLON.



BLOCK BY SURVEY DEPT. CEYLON.

FIG. 2

subsequent days, the total wash corresponding to about 2'' of rain. It is easily seen, however, that if the pit capacity were increased to 3'' the wash would be stopped. It would also be considerably reduced if the percolation rate into the soil could be taken as more rapid. By means of such diagrams based on their own material estates may usefully examine the adequacy of any proposed scheme. The records for a complete year at Kuala Lumpur were examined in the way described and there were four occasions when the conditions assumed would have proved inadequate and led to overflow. Three of these would have been prevented by an increase of capacity from 2½'' to 3'' of rain, but the fourth would have required pits of 4'' capacity. It should not be difficult to judge the point at which the risk of overflow is so small that it is economic to neglect it.

The calculation of capacity is very easily made on a cross-sectional basis if the pits are placed continuously on the contour. By way of example it is easy to see that a pit 2 feet wide by 1½ feet deep will have a cross section equal to that of 2'' of rain over 18 feet of ground (432 sq. inches in each case). Hence continuous lines of pits of those dimensions placed at 18 feet intervals would hold up 2'' of excess rain. It is easy to adopt the calculation to the planting distances and other factors affecting a particular case. On the same basis the capacity of a terrace may be estimated in terms of its width and inward slope, remembering that in this case the cross section is triangular instead of rectangular. When the line of pits is not continuous the calculations must be based upon cubic contents. As already stated a distinct limit is set to the usefulness of silt-pitting if the pits do not empty themselves by natural percolation in a reasonable length of time. Fortunately it is unusual to find heavy impervious soils on the hill sites which stand most in need of silt-pitting. Under ordinary circumstances pits should drain clear in two or three days. If they do not normally dry up between one period of rain and the next the sodden conditions themselves produce an impervious state. For the action of the surface soil of the pit is that of a filter and its pores tend to become clogged with a fine slime extracted from the water. This clogged state of the lining of the pit will become permanent unless intervening dry conditions occur. The advantage of dry conditions is that this lining shrinks and cracks and this helps very much to keep the pit functioning properly.

Apart from the uselessness of water lying stagnating in the pits there is the positive objection on health grounds of providing such breeding places for mosquitoes. It is clear that a pit which is always half-full of water has no distinct advantage over one that is half-full of soil, or that it can be laid down that, at any rate in areas where health considerations are important, sluggish silt-pits should be filled in until their capacity is such that they empty themselves in a safe period and modified methods adopted. The safe period from this point of view might be set at a week. Hard and fast rules are hard to lay down because of the varied distribution of the rainfall, but the man on the spot can easily judge from frequent observation how far his pits are proving a health menace and deal with them accordingly. The type of diagram already discussed can be used to examine the periods during which the pits are never empty and the possibility noted of these being longer than the safe period. During the year examined the analysis indicated two periods only during which pits would hold standing water for longer periods than a week and these were very little in excess. During very wet periods water lies about under any conditions, so that the pits do not constitute a new problem though they may much aggravate an old one. Oiling may be resorted to if necessary, but this does not constitute a full solution for the whole problem owing to the great number of pits and the big chance of overlooking some of them. Vigilance is the first requirement, and it may call to its aid both oiling and the partial filling in of pits.

While on the subject of health there is another aspect of the matter which has been raised. The increased percolation into the hillsides produced by silt-pitting may cause unexpected seepage at the base, and so provide new breeding places for mosquitoes. Since forewarned is forearmed, this need be no menace if provided for by drainage. It may simply be looked upon as a possible slight increase in the total cost of carrying out the complete scheme. Seepage appearing sporadically in the neighbourhood of particular pits is in the same class as pits which retain water too long.

The next point which comes up for consideration is that of pit maintenance. Where the work of the pits is strongly reinforced by a ground cover the question is not urgent, but it becomes so in many cases where the system must be regarded as permanent. It has already been emphasised that a properly devised system should not silt up quickly, but the action is not always entirely avoidable. The advice has often been given to let one system of pits fill up and then cut others in fresh situations. The main reason for this seems to be to avoid disturbing the feeding roots which come to the old pit on account of the richer, moister and better aerated soil conditions there. I cannot find myself in agreement with this course of action in rubber. The two main objections are, first, that a considerable period of inefficiency must intervene when the old system is disappearing and the new system is not yet dug, and, second, that by the time that several new sites have been dug over a severe breaking up of the main root system of the trees must be effected. A regular plan of cleaning pits, on the other hand maintains them at their best and involves only a disturbance of young feeding root-lets. It also tends to obviate that clogging up of the pit already referred to. The decaying material which is apt to collect at the bottom of a pit is not lost as food for the tree just because it is removed and spread on the surface.

Probably the most debated point of any that comes within my province is the question as to which side of a silt pit the spoil should be placed. A bund immediately above a pit stops the surface water from finding its way in naturally, while when the bund is placed below it reinforces the pit both as to strength and capacity. Hence the common practice of placing the bund below has common sense to commend it. But there are further points to be considered. It is equally good sense to contend that, since silt-pitting has as its main object the combating of the natural tendency of the soil to reach the bottom of the slope, the spoil should therefore be thrown out up the slope. This applies particularly to the spoil obtained from cleaning. But the main advantage which advocates of this method have in view is that of using the bund itself to form a water catchment. Indeed some people so emphasise this aspect as to look upon the pit merely as the best means of winning the soil to form a bund. This is in the generality of cases an exaggerated view to take. A bund holds up the water in a large shallow puddle. This certainly gives the maximum surface for the water to drain into the soil and to that extent disposes of it quickly and naturally. When the soil is pervious enough to do this there can be no objection. But it must be very strongly emphasised that on the heavier types of soil when the puddles stand about for some time they produce a very deleterious effect on the physical conditions of the soil surface. The ideal to aim at is to utilise both bund and pit to their fullest extent, which means that they must be separated in some way or another. That seems to be the central fact of the case with its accompanying increase the expense. There are many ways of planning the utilisation of the spoil in the form of a separate bund. The best way is a continuous bund on the contour between the rows of pits, or where this is not possible separate portions may be given a horse-shoe form, the ends carried up and away from the pit below. In all cases everything must be done to avoid standing puddles round the base of the trees.

The secondary advantage of placing the bund on the upward side of the pit is that on steeper slopes an ultimate terrace formation may be attained, or it may aid when a combination of pit and terraces is being cut.* Such cases require considerable care in consolidating the bund against attrition and may depend for success on direct methods of consolidation. Such cases are in a class to be considered on their individual merits, since any method which begins with one form with the intention of evolving into another brings in too many local factors for successful generalising.

Many different forms can be devised for the cutting of silt-pits, each of which may have its special advantages. No doubt the narrow ditch from along a contour is the best. But owing to the fact that pitting is always done in separate sections, there is a very large number of ways in which they may be disposed. Where planting is not on the contour and pits are dug between each group of trees, there is a natural tendency to an echelon formation such as is required to break up surface flow. The narrow pit gives the large surface for percolation and also the least possibility of losses by evaporation. The depth of the pit is quite a local matter, depending upon subsoil permeability. Frequently a much less pervious condition of soil exists at the depth of 18" or 24", and there is not much advantage to be gained by cutting into this. If in special cases there is prospect of cutting through a stiff layer into a more pervious sub-stratum, this should be favourably considered.

The combination of some form of modified silt-pit in conjunction with terracing on the steeper slopes has much to commend it. Terrace maintenance is improved and the functioning simplified by shallow pits dug at the back, the spoil from which is dragged forward and spread on the edge. In this case surface water reaches the pit from both sides, since the terrace slopes inward. The capacity of the terrace to hold water is much increased in this way, and the tendency for water to lie in puddles is also diminished.

The main features which emerge from these considerations may be summed up as follows :—

1. In the first place a low-growing ground cover must be looked upon as the main line of defence in regard to soil erosion. It protects the soil from direct impact of the rain as nothing else can do; increases the absorptive capacity of the soil while at the same time binding it together; and maintains healthy conditions in the soil surface.

2. Silt-pitting may be very useful in conjunction with a cover, in which case it may be either temporary or permanent and only in the last resort should it stand alone as the sole means of protection.

3. Unless the silt-pitting system is definitely intended only as a temporary measure it is best to maintain the original system by periodic cleaning.

4. Since it is very problematical whether a pit which retains water for a period of many days has any advantages, it is advisable for health reasons to fill up such pits till their capacity is reduced to the required extent.

5. Simple bunding at the side of the pit is best done on the downward side in most cases: but where the bund can be moved away from the pit a variety of improved arrangements can be made to utilise the catchment value of the bund.

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* Compare the combination described by R. P. Hunter in "The Planter" for September, 1928.

THE EMPIRE MARKETING BOARD.

ESTABLISHMENT OF THE BOARD AND OF THE EMPIRE MARKETING GRANT.

(The following account of *The Empire Marketing Board* is taken from the *Report of the Research Co-ordination Sub-Committee* of the *Committee of Civil Research* for 1928. It is published as matter of general interest concerning a body the activities of which are of great economic importance. —*Ed. T. A.*

THE Empire Marketing Board was set up in May 1926, in accordance with a recommendation contained in the first Report of the Imperial Economic Committee, to assist the Secretary of State for Dominion Affairs in the administration of the Empire Marketing Grant. Its financial resources, which take the form of a grant-in-aid, amounted to £500,000 during the financial year 1926, and to £1,000,000 per annum in current year. In the vote passed by the House of Commons in August 1926, the grant was defined as being "for furthering the marketing of Empire products in this country." No precise definition of the term "Empire products" has as yet been sought. In practice the Board has so far limited itself in the main to dealing with agricultural produce, because the Imperial Economic Committee was confined by its terms of reference to dealing with raw materials and food-stuffs, and it was thought wise in the early stages to act mainly on the results of that Committee's work. By agreement with the Dominion Governments the grant has been held to be available for the furtherance of the marketing of home, as well as overseas, agricultural produce. The Imperial Economic Committee, at the outset of their first report, laid down the principle that the home producer had the first claim in the home market, and this principle has been adopted as the policy of the Empire Marketing Board.

THE MEMBERSHIP OF THE BOARD.

The Secretary of State of Dominion Affairs is the Minister responsible to Parliament for the expenditure of the Empire Marketing Grant, and acts as Chairman of the Empire Marketing Board. The English and Scottish Departments of Agriculture are represented respectively by the Parliamentary Secretary to the Ministry of Agriculture and Fisheries and the Parliamentary Under-Secretary of State for Scotland. The Treasury is represented on the Board by the Financial Secretary to the Treasury, and the Department of Overseas Trade by the Comptroller-General. A representative of the Government of Nothern Ireland is also invited to attend when matters affecting Northern Ireland are under discussion. Each of the Dominions as well as India has a representative on the Board, and one member represents the Colonies and Dependencies. These oversea representatives are, or have at some time been, also members of the Imperial Economic Committee, and thus establish a useful link with that body.

THE BOARD'S PROGRAMME.

The programme of the Empire Marketing Board is to a large extent based upon the work of the Imperial Economic Committee. Its functions were originally outlined as falling into three divisions :—

(1) Publicity and education;

(2) The promotion of scientific research and economic investigation;

(3) Particular schemes for the improvement of production and marketing.

It is only with the second of these functions that we are concerned, for the discharge of which the Board decided, after careful consideration, and with the full agreement of its oversea representatives, to appoint a small lay Committee, composed of members of the Board itself. This Committee, which was called the Research Committee of the Board, was originally constituted to include two home and three oversea representatives, the Parliamentary Under-Secretary of State for the Colonies being regarded as representing the Colonies and Dependencies. Subsequently two additional members were added—one the member of the Board who represents the Colonies and Dependencies, and the other the Financial Secretary to the Treasury in the late Government. The economic investigations are mainly conducted directly by the Board's officers, but as explained in the following paragraphs, the Board's policy aims at the promotion of research through existing agencies. This has been emphasised by the recent decision of the Board to change the title of their Committee to the Research Grants Committee.

THE SPECIAL POSITION OF THE BOARD.

In considering the position of the Empire Marketing Board it is impossible not to be struck by the departure that its appointment marks from the previous policy of the Government in the financing of research services. Hitherto, whenever the Government had decided to develop research in any particular field, care had been taken to avoid the creation of additional government agencies, by providing for the service to be carried on through the appropriate department of government, if there was one in existence. In these circumstances it was not unnatural that the departments already engaged in the financing or promotion of research under Government should have watched with anxiety the progress of so novel an experiment. There was, no doubt, a danger that in its early stages of evolution the Board might find difficulty in adjusting its relations with the older departments. Failure to do so would undoubtedly have led to friction and waste of effort. It is true that the Government decided at the time when the Board was brought into existence that it should normally act through the agency of existing departments and institutions, and should avoid undertaking research directly if there was any such department or institution to which the work could be entrusted. The field covered by the Board was, however, so wide that important work would almost certainly be required which no existing department or institution could undertake and for this reason the most unreserved co-operation between the Board and the existing departments was essential if overlapping was to be avoided.

Before dealing with the actual experience gained during the short period the Board has been in existence, we think it desirable to draw attention the difference in the position that it occupies from that of the other government departments concerned with the promotion of research. The latter without exception are bodies charged by the British Government with special responsibilities for particular fields of research. They are in every sense the servants of that Government and exist to serve its interests in those fields. This, however, is not the case with the Empire Marketing Board. Its funds are subject in every way to the conditions applicable to other moneys provided by Parliament by way of "Grants-in-Aid." But, unlike Government Departments, the Board is an inter-imperial body, in which, owing to its constitution, procedure and policy, the overseas Governments have a particular interest. Accordingly, the British Government have made it a practice to consult the Dominion Governments in regard to all developments of the policy and programme of the Board. Moverover, the Board normally requires a financial contribution from Dominion and Colonial Governments or research

organisations or particular institutions as a condition of making a grant from its funds. A body such as the Empire Marketing Board cannot therefore be expected to look upon problems from the same angle as purely British departments. This is particularly the case when it comes to deciding the order of priority to be given to particular proposals submitted to the Board. It may well happen that from the point of view of the British departments concerned the urgency of a given proposal is less apparent than it is to corresponding authorities in the Dominion submitting the proposal. Similarly proposals brought before the Board by the British departments may not always have the same importance in the eyes of the Dominion representatives on the Board. Such differences of view are both natural and legitimate. They can best be accommodated by the maintenance of the closest relations between the Board and the British departments concerned, on the lines explained below. Since applications from the Dominions and Colonies are considered by the Board, as are applications from departments in this country, a similar scrutiny of all proposals, whether from the United Kingdom or from overseas, is necessary.

THE RELATIONS BETWEEN THE BOARD AND THE BRITISH DEPARTMENTS ENGAGED IN RESEARCH.

We are only concerned with the side of the Board's work which deals with the financing of research schemes. In view of the special interest of the Department of Scientific and Industrial Research, the Medical Research Council and the Departments of Agriculture in the smooth working of the machinery devised to this end, we set up a sub-committee consisting of the representatives of the departments named and of the Empire Marketing Board to review the existing arrangements and to submit any recommendations that they might consider desirable. The sub-committee submitted a report by which we have been greatly assisted.

In this field the Board has interpreted the instructions of the Cabinet by arranging that, when applications for grants are received, they should in the first instance be referred automatically to the appropriate scientific department before they are considered by the Research Grants Committee of the Board. Under this procedure proposals for expenditure on medical and industrial research are referred respectively to the Medical Research Council and to the Department of Scientific and Industrial Research, which are asked to give their opinion on the merits of the proposals, and, if they consider that a particular proposal should be accepted, to indicate how it may best be carried out. Similarly, applications dealing with agricultural research are referred to the Development Commission and to the Departments of Agriculture. This procedure is followed by the Board in dealing not only with applications received from Government departments in this country, but also with those submitted by institutions and other outside bodies both in this country and in the Dominions, Colonies and Dependencies. In this way the departments concerned are kept in the fullest touch at the earliest stage with proposals under consideration by the Board. It is particularly necessary that there should be a thorough scrutiny by the departments of proposals referred to them by the Board, as it is obviously very difficult for the Board to withhold its assent in cases where the departments recommended that a grant should be made. The departments have therefore a real responsibility for the decisions on proposals on which their advice is asked.

The research departments of Government communicate to the Board proposals for research for which a grant is desired and keep it acquainted with all developments of their research work which might affect the Board's work or interest it, since the Board might wish to co-operate financially at a later stage. Similar close co-operation is important especially in agriculture, owing to the possible transfer of scientific personnel to institutes overseas as the result of grants by the Board. We realise the

advantages which may be expected from such transfers, but in view of their responsibilities, the research departments and especially the Departments of Agriculture are especially consulted by the Board on any proposals from the Dominions and Colonies which may result in calls being made on the staff of the research institutions in this country. Where the Board decide to send a worker overseas, the departments concerned are normally able to render assistance in putting him into touch with the scientific authorities in the Dominions.

When research is carried out by a British department either partly or wholly as a charge on grants made by the Board, once the scope of the work to which the grants are applicable has been defined by the Board after consultation with the department, the whole responsibility for carrying out the work and administering the grant rests with the department. This arrangement is to the advantage both of the Board and the department especially in the recruitment of staff which in general the existing departments can undertake more effectively than the Board. In particular, elaborate accounting arrangements for the division of costs between the Board and the department and duplication of accounting work by the Board and the department are avoided as far as possible. Questions of this kind are considered informally from time to time in the light of experience by the financial officers of the Board and the departments, where necessary in consultation with the Treasury. The continuation of, and the amount of further, financial assistance by the Board in the later development of research so financed will depend in each case on the nature of the progress report submitted by the department to the Board.

In the case of research paid for jointly by a department and by the Board, appropriate steps are taken to fix the relative contributions of the department and the Board. The appropriate method can only be determined on the merits of each case by the Board through direct negotiation with the department concerned. Obviously the Board cannot be expected to make grants which would have the effect of relieving the votes of the departments of expenditure which they should properly carry. On the other hand the departments cannot expect Parliament to vote them additional moneys which would have the effect of relieving the Board of what would be a proper charge on its funds. Cases of immediate overseas interest have, however, arisen in which the Board have considered it reasonable to defray the whole cost of the research, without seeking to obtain any contribution from the local Government or organisations concerned. When, however, the Board makes grants to institutions and outside bodies its policy is to secure, whenever reasonable, contributions on a pound for pound basis.

The Board endeavours wherever possible to avoid undertaking the direct conduct of research, and does not propose to appoint permanent staff engaged on scientific as apart from economic investigations, but in cases where no scientific service is available (especially in connection with its economic surveys) the Board may find it necessary itself to employ temporarily officers of scientific training. Before such special arrangements are made by the Board, there will be prior consultation with the departments most nearly concerned.

In the course of its work, the Empire Marketing Board has established relations not only with departments in the country, but with independent and in some cases with foreign organisations interested in the promotion of research. There is, we realise, a risk that offers of financial assistance from such sources may deflect the research policy of British departments from the path which they would otherwise take. This danger can best be obviated by the research departments and the Board avoiding even contingent liabilities until the problem has been jointly considered.

From time to time cases will no doubt arise where, though one research department is principally concerned, another may be glad to be associated with the proposed research from the point of view of its special interests. The closest co-operation between the Board and the Departments is particularly essential in dealing with border-line cases of this kind. In most cases satisfactory arrangements can be made by discussion between the heads of the institutions at which the work is to be carried out and between the officers of the departments concerned; but in others the question could be discussed at the quarterly conference of scientific departments.

The present system may be summarised as follows :—

(a) Before any proposal for expenditure on research is considered by the Research Grants Committee of the Board, it is referred to the appropriate scientific department which is invited to give its views on the proposal, and, if they recommend its approval, to indicate how the proposed research can most effectively be carried out.

(b) The above procedure is followed not only in dealing with proposals submitted by British Government departments, but also those received from Dominion Governments, or independent institutions either in this country or in the Dominions.

(c) Research financed by the Board is, where possible, undertaken by or through the appropriate department or institution, and the Board avoids incurring direct responsibility for the conduct of research, except in cases where there is no department or institution by which it can be undertaken.

(d) In general, the policy of the Board is to avoid the direct employment of scientific personnel.

(e) The procedure described in (c) and (d) above is not intended to preclude the Board from itself employing officers with scientific training, but they will not be employed for the purpose of undertaking scientific as apart from economic investigations, border-line questions as they arise being considered on their merits with the appropriate department.

(f) The departments concerned endeavour to keep the Board fully informed about research development which may affect or interest the Board, not only in cases where it is proposed to apply to the Board for a grant, but in others in which the Board or the departments may be interested at a later stage.

(g) The Departments of Agriculture are consulted on any extensive development in the Empire wihch may be expected to lead to a transfer overseas of scientific workers at present employed in the Agricultural Research Institutes in this country.

(h) The Board and the scientific departments are equally free to initiate research proposals, and, while normally it is possible to reach agreement on programmes by inter-departmental discussion, border-line cases that cannot otherwise be determined can be referred to the standing quarterly conference of scientific departments.

(i) Questions of the relative priority to be given to applications are decided by the Board in the light of its special responsibilities to the oversea Governments and in consultation with the British departments concerned.

(j) In the case of research financed by one of the British departments with the aid of grants from the Board, the amount of the Board's grant and the scope of the work to which it is applicable are determined on the merits of the case by the Board after consultation with the department.

FRUIT GROWING.*

NO doubt some of you will, after perusing the title of this paper, maintain that the whole business of fruit-growing, together with its marketing problems, is a vital one to us and needs investigation and concerted action to place it on a semblance of a business footing. Apple growers especially, no doubt, feel that, unless something is done to place the marketing of their produce on a better footing, this particular phase of orchard activities will cease to be attractive to them. Whilst I would agree with you in this, it is not my intention to deal with this aspect of the problem, except very briefly, but to take a few facts which, in my opinion, are needful of investigation and attention by fruit-growers as a body, and which apply more to the first operations of establishing an orchard, and to its subsequent management, than to the ultimate disposition of the yields.

I propose to start at the beginning of the life of orchard trees, and to give some facts relating to them whilst still in the nursery, and then to follow them into maturity. It will be readily agreed that the first essential in planting an orchard is to secure the best trees available. No farmer would think of sowing a paddock with seed of which he was not certain with regard to variety and grade, and this being so with regard to a crop which will only occupy the land for a few months, how much more should it apply to the planting of trees which will be looked to provide a yearly income for a long period.

It is the nurseryman's business to provide trees to the best of his ability and right here it becomes apparent that the nurserymen themselves need assistance, and would welcome any attempt to carry into effect some of the suggestions contained in this paper. It is, in a number of instances, very difficult for nurserymen to secure buds or scions for propagation from trees which have a proved record for consistent and heavy bearing of quality fruit. This brings us to the first important matter in connection with which research work is urgently needed in Australia, namely:

BUD SELECTION.

Bud selection is a vital matter and needs investigation even more urgently than is commonly realised. Most of you will be acquainted with the fact that, in orchards comprised of leading varieties of commercial fruits, there are distinct variations in the same variety, some of them even departing from their usual characteristics so far as to become hardly recognisable. To propagate from such a tree would not be a safe procedure, no matter how slight the variation may be, and I now put forward a suggestion on behalf of future orchardists of this State, that in connection with the leading commercial varieties—which, after all, are comparatively few in number—a number of trees should be propagated from the finest proved stock available, planted out, and after having proved themselves to be worthy of being the foundation of future orchards, the scions could be supplied to nurserymen, who would then in a measure be sure of the quality of the trees propagated. I am quite aware that this could not be done by private enterprise, because it is comparatively lengthy, and quite unremunerative procedure, but if undertaken by the Department of Agriculture, I am confident that the small expenditure of maintaining these few score of trees would be warranted, as it would, in a measure, be an insurance against orchards being planted with varieties with a doubtful or very inferior parentage.

* By H. N. Wicks in Bulletin No. 219 of the Department of Agriculture of South Australia.

In support of this claim I would point out two significant features in the position. Firstly, the present day nurseryman has to obtain buds and scions for propagation of his saleable stock in trade, from any source available, which is usually a private gardener adjacent to his nursery. The drawbacks to this practice are too evident after my previous remarks to need further comment. Secondly, in other parts of the world, the importance of this matter has been realised and action is being taken with marked results. In some of the States of America, it has been made illegal for a nurseryman to propagate a certain variety of fruit tree from any parent other than those especially selected for the purpose by the Government. This being so, can a young country like Australia, which must come into direct competition with other countries on the world's markets, afford to take any chances with regard to its future plantings of commercial lines of fruit trees.

By commercial lines I mean such varieties as the Aoorpark Apricot, together with perhaps one or two other varieties of the same class, apples such as Cleopatra, Jonathan, Dunn's Favourite, Granny Smith, and a few others, and in short, those varieties which are planted in large quantities for production of fruit which will ultimately be sold—either dried or fresh—on the world's markets. The establishment of a small block of trees in one or two districts would be sufficient for the purpose, and would not be costly to either establish or maintain, and I am sure, would prove in years to come to be productive of many times the cost of maintenance, in the production of better yields of finer quality fruit, which we must produce if we are to hold a position in the world's markets.

STOCK TESTS.

Let up suppose, for the time being, that the conditions outlined above are at present in operation, and that bud selection from pedigreed trees is common practice. We are then immediately faced with another problem of no less importance than the former one. I refer to the matter of stocks for the various trees. In dealing with this matter I intend to discuss only those lines which I consider need attention most urgently at the present time. For those who are not familiar with phrases usually applied in nursery practice, allow me, before going any further, to mention that the word stock generally applies to the seedling or cutting into which the bud or graft of the required variety is placed, the greater portion of same being removed when the bud starts into growth. For the purpose of this talk, and that you may better follow my remarks, I will call these seedlings and cuttings, stock or stocks, and the buds or grafts which are placed in same, scions.

There is an appalling lack of knowledge the world over with regard to the relationship between stock and scion, and the effect one has on the other. That each is affected by the other is quite beyond dispute, but just what effect is produced by combinations is unknown and there is room for a vast amount of investigation. It is a remarkable fact, but very noticeable to any one who has had much experience in propagation, that not only has the stock an effect over the growth and habit of the scion, but *vice versa* also. If we take a stock which has a tendency to go straight down by forming one or two tap roots—such as pear stocks usually do—it will be noticed that if an upright variety such as Kieffer's Hybrid is budded on to it, the root system apparently does not alter. But if we work a scion of widely spreading habit on to the same stock, the root system immediately tends to take on a spreading tendency, thus proving that both stock and scion are affected one with the other.

The root stocks at present in common use in Australia are not altogether satisfactory under all conditions, and in some instances are very unsuccessful. Let us take a few examples. The stock most generally used for plums and

prunes is *Prunus myrabolana,* commonly called Myrobalan, which is a very thriftly, strong grower, and is no doubt eminently suited for quite a number of varieties, but nevertheless has its drawbacks. Those who grow prunes of the d'Agen or Splendor varieties will be fully acquainted with the shoots which persistently appear from below the union of stock and scion in these varieties. These crown shoots are often erroneously called suckers, but in reality are quite different, being shoots from the main stem of the tree, and not from the roots, as in the case with suckers. These shoots are the direct result of the unsuitability of the Myrobalan stock for these particular varieties for the following very simple reason. Both these varieties are not so strong in their growth as the stock itself, and these shoots are the results of a restriction of growth at the union of stock and scion, and are the only means the stock has of getting rid of its surplus growth. If an excessively strong grower, such as some of the Japanese varieties, is budded on to the Myrobalan stock these shoots will very rarely, if ever, appear. Quite a number of the European varieties of plums are not sufficiently robust to occupy the whole energies of the Myrobalan stock which forms its foundation, and in some instances these resultant offsets from the base of the tree are a source of continual annoyance to the orchardist, having to be removed periodically.

Nevertheless, at the present time, there is no stock which will give such good, allround results as the Myrobalan seedling, and, therefore we must put up with the trouble of these off shoots in the meantime, but I think that a stock of slightly dwarfing habits, but with the vigor and hardiness of the Myrobalan, would be more suitable for a majority of the slower growing varieties of European plums.

The majority of apple trees at the present time in Australia are worked on to the Northern Spy stock which is completely blight proof; thus trees on this stock are not affected underground with the American blight, commonly called woolly aphis, but this pest is in this way confined to the top of the trees where it can be attacked and destroyed to a certain extent.

Recently, there has been a controversy in the fruit-growing periodicals of Australia debating the merits and demerits of this stock for apples, and a number of writers maintain that the seedling stock is superior in many ways, and that the blight which attacks the roots never becomes so strong as to eradicate or kill the parent tree. I have no desire to enter into a controversy on this very debatable subject, but will go so far to say that it is claimed by some growers that in some districts of Tasmania the trees fruit more heavily and more consistently on the seedling stock, having good crops every season.

One of the greatest factors at present worrying the minds of apple producers in this State is the tendency of some leading varieties to crop on alternate seasons only, and until experiments are carried out under the conditions in which this fruit is grown, who is to say that the matter of stock relationship to the scion—if properly understood—will not overcome this discrepancy? There is no doubt that at present, in this State at any rate, our apple production seems to be, in a great measure, an every-other-year job and the producers would be far better off if a happy medium could be secured. There are numerous theories relating to this matter, but none of them are to my mind anywhere near conclusive. I have old trees under observation standing on the seedling stock, and they are undoubtedly more consistent than those on the Spy, but this may be on account of their age. However, I am sure that investigation in this connection will not be wasted. No doubt some will reply that these tests have already been tried out in other parts of the world. I am quite ready to grant all this, but would

point out the futility of taking these results and applying them to our conditions. The only way to obtain authentic tests is to make them under the conditions in which the trees are ultimately to grow.

Rules of horticulture in regard to propagation and other factors which must be strictly adhered to in other parts of the world can often be entirely eliminated here or altered to a great extent, and it is useless in this class of work to take as final the results obtained in other parts of the world where conditions may be very different to those obtaining here.

With regard to this stock question, I can see very serious trouble ahead for pear growers unless a blight-proof stock is found for these trees, because the stocks at present in use for pear trees are very susceptible to the pear woolly aphis, which is playing havoc in pear plantations all over the Commonwealth, and it is essential that either a sure remedy for this pest be obtained or otherwise we must look to combat the evil by a suitable resistant stock.

Having outlined suggestions whereby planters would be able to secure better trees should these suggestions be put into force, I will now deal with several matters which will apply after the trees are in the orchard and commencing to bear, and which, so far, are not being investigated locally as they should be.

INTER-POLLINATION OR CROSS-FERTILISATION.

Perhaps the foremost matter in this connection would be a closer study of inter-pollination or cross-fertilisation. That great benefits are to be secured by this practice in certain districts and under certain conditions is now an established fact, and evidence is very plentiful on this point, and it is the exception now-a-days for a planter to ignore this factor when planting his orchard, whereas a few years ago this was looked upon to be a fad. My experience in this connection covers a number of years of practical experimenting, and results were not lacking from the beginning. My first trial of any importance was on a block of about three acres of Jonathan apples, which although being light crops, were not doing their duty.

Having tried every method of pruning I could conceive, together with manuring tests, I left them unpruned for a season with even poorer results than before, although they were most profuse in blossoming. The following season I placed a tin or a bottle in a number of the trees filling same with water, and then placed a limb of another variety of apple which was blossoming at the same time as the Jonathan in the water to keep it fresh. This was done at the time when the trees could be classed as in full bloom, and the small limbs containing the foreign blooms kept fresh until the Jonathans had completed their blossoming period. The result of this test was so remarkable that the following season I used every available tin, and scoured the district for blossom, and managed to pollinate several acres by placing the twig of foreign bloom in every tree. The result of this was that the trees carried their first payable crop. So convinced was I of the necessity of this practice, that I lost no time in heading off about 200 trees ranging from 10 to 16 years old, and interspersed throughout the blocks of Jonathans, and grafting varieties on to them which would pollinate the Jonathans. That the same necessity exists in every district I would not venture to suggest, for I believe that in some districts cross-pollination is not as necessary as it is in other areas, but just what causes the difference we do not at present know, or cannot even surmise, but I consider that very probably this could be ascertained by research work. Then again, some varieties are quite self-fertile and pollination is unnecessary, and complete data as to which varieties would be benefitted by this practice is not available, but if a schedule was available of varieties which, under most

conditions are known to be self-fertile, it would be of great benefit to planters generally. Just what makes blossoms infertile is somewhat of a problem and research work would be valuable in this connection, and it is quite possible that some chemical action could be discovered which could be manipulated by growers to enable fruit buds to be stimulated into fruit production. As far back as 1914, the United States Journal of Agricultural Research reported on experiments with a Nitrate of Soda Spray with this end in view. A solution was concocted with the following ingredients:— Nitrate of Soda 50 lb. Caustic Soda 6 lb. and Water 50 gallons, and this was thoroughly sprayed on to the trees at a period of the year corresponding to about August 1st, in Australia. The report on the experiment states:— "It is evident that at least under certain conditions some varieties of apples and pears that are more or less self-sterile may have their crop production materially increased by dormant spraying with solutions of Nitrate of Soda plus Caustic Soda. The combination of Nitrate of Soda and Lime Sulphur is apparently capable of bringing about the same results. Aside from the effect on crop production there has also been a very noticeable improvement in the colour, abundance, and vigor of the foliage, and it seems possible that Nitrate spraying of dormant trees may be a valuable supplement to the ordinary fertiliser practices in obtaining quick results in orchards suffering from lack of Nitrogen. The writers will make no attempt at present to explain the peculiar effect of Nitrate of Soda in increasing the production of more or less self-sterile varieties of fruits, or in improving foliage growth."

From the foregoing extract it will be seen that the matter of assisting infertile blooms to become fertile and produce fruit by chemical process and human agency is not only feasible, but has actually been carried into effect.

This being so, it seems quite reasonable that in this age of science the time will come when we may actually be able to prevent the alternate cropping of so many of our fruits by chemical application, and thus give us more staple and even production.

At present an extremely heavy blooming does not necessarily mean a heavy crop of fruit, this fact pointing to a lack of something in the blooms themselves. Tests of this character would not be difficult to arrange, and might bring to light much that might help us.

SPRAYING.

This all-important part of fruit culture has, through recent years, been forced to the foremost of all orchard operations by reason of the rapid increase in the pests we have to fight. The hordes of attacking parasites which continually beset the present-day orchardist are sufficient to break the heart of any but the hardiest and most optimistic in the ranks of the producers, and the sprayer is now a vital factor in the production of good fruit. This is fully realised by all who have to earn their living by fruit production, and yet there is an immense amount of laxity and even carelessness in applying the different formulas and more uniformity is essential in this connection. Such spray mixtures as Bordeaux are often spoiled before application by erroneous methods of mixing and application. Accuracy in preparing such sprays as Arsenate of Lead is essential if we are to avoid excessive arsenic content in the fruit when marketed, carelessness in weighing the ingredients being one of the chief faults in this connection. The Lime Sulphur solution has now taken a permanent place in a number of orchards instead of Bordeaux mixture, but this material is not safe to use when the temperature of the atmosphere is over a certain limit, and information regarding just what this limit is would be valuable. Further, some of our leading varieties of apples and pears will not stand this solution at the

same strength as will others, causing damage at times to fruit buds, and information in regard to this would be well worth while.

No doubt you will consider that a fairly comprehensive programme has been outlined, but in defence of the matters brought forward, I will conclude with a brief statement of the value of the fruit industry to us, and I am sure you will agree that it is of sufficient magnitude to warrant investigation and assistance wherever possible.

Taking the last 10 years into consideration and studying the following figures, which have been courteously supplied by the Department of Agriculture, we notice a very steady rise in the approximate annual value of fruit yields of South Australia, the approximate values being as follows :—

1917-1918	...	...	£411,577
1926-1927	...	...	£732,586

This rise of nearly a third of a million pounds has been very consistently distributed throughout the period under review, and in no instance has a season since the 1917-1918 period shown a return as low as that year.

Of course, one or two seasons stand out pre-eminently, the highest figures being for the season 1923-1924, when the value was approximately £820,000. I am sure that you will agree that an industry of this magnitude is worthy of all we can do to place it on a footing which will enable its products to compete successfully on the world's markets.

In briefly touching upon the marketing problem at present before us, I consider that urgent attention should be paid to the matter of finding new outlets for our exportable surplus, India and the East both being worthy of investigation in this connection.

BANANA CULTIVATION IN PALESTINE*

In a leaflet issued by the Palestine Department of Agriculture and Forests on the prospects of banana cultivation in that country, it is stated that there are considerable possibilities for a banana industry of moderate dimensions in Palestine. Climatic disabilities, as compared with the principal banana producing countries, are offset by the geographical position, Palestine being in close touch with Eastern European Markets where bananas arrive at present only in small quantities. It is stated that the Canary Islands production is reputed to have reached its limit, and that the Central American production has nearly reached its maximum under existing conditions. These producers, it is stated, will probably find that Western Europe can absorb all their available supplies. Western Europe would also be the first and natural market for a West African banana industry, when this develops. The extent of the demand that might be created in Eastern Europe, including Russia, within a relatively short period can be visualised when it is considered that the whole of the world's commercial banana trade has developed during the past forty years.

At present, cultivation in Palestine is confined to some 180 acres, and most of the plants grown are of the Cavendish variety, similar to those grown in the Canary Islands. The best producing areas are the coast Beisan at the lower end of the valley of Jezreel, and the Semakh area in the Jordan valley just south of Lake Tiberias. It is estimated that five to ten thousand acres of bananas could be brought under cultivation in these areas.

* Empire Marketing Board. Weekly Fruit Intelligence Notes. Vol. II., No. 21., 22nd August, 1928.

EXCELSA COFFEE.*

THE recent hurricane has greatly accentuated a need already felt by the coffee planter long before the storm—that is, the need for new coffee plantings. Owing to the widespread damage to the coffee, extensive new plantings must be made if the plantations are to continue on anything like their former scale.

At the time these plantations were made there was no question of varieties. Only a single variety was available to the planter. To-day he may choose any one of more than a dozen different sorts of coffee. Among these, Excelsa coffee has proved of particular promise for planting under certain conditions, and the experiment station wishes to place the information relating to it before the planters.

This variety was discovered about 25 years ago in West Africa. It was soon tested by the Dutch in Java, and presently hundreds of acres there were planted to it. Seeds of Excelsa coffee from Java were planted by the station at Mayaguez in November and December, 1915. These plantings to-day are showing us something of what we may expect of this variety.

The discoverer of Excelsa coffee, Aug. Chevalier, reported that it is adaptable to a dry climate, mentioning it as found in one locality with a 6 months dry season and only 1 to 1·5 meters rainfall in the year.

In the wild state it grows in forests below 500 meters altitude and this natural range is presumably the best suited to it. Dr. Cramer of Java says that while it may be grown at more than 4,000 feet it would hardly pay at that altitude and the growth is much slower.

Excelsa may be grown with or without shade, an important adaptability at the present time with the shade trees so extensively damaged or destroyed. At the station it has grown well both under shade and unshaded. In Java it is said to be grown generally under shade, but a lighter shade is preferred for it than that used for other coffees.

Though Excelsa coffee will, of course, grow better in a rich soil, it does not require such, and will flourish in soils unsuited to the best development of Arabian coffee. The root system is notably strong and vigorous, and from the older trunks large roots may be traced far out from the tree.

Chevalier reported Excelsa coffee in the wild state to be a tree from 8 to 15 meters and even sometimes 20 meters high. Grafted trees at this station have attained a height of about 23 feet in 9 years. The growth is very vigorous and the trees attain so larger a size that they must be widely spaced. In one of the station plantings the branches of 13-year-old trees spaced 12 feet apart now meet. A closer permanent spacing than 12 x 12 feet would seem inadvisable. However, where the seed supply is abundant and land scarce, a closer planting may be made and alternate trees removed as the growth warrants. In this way the earlier crop will show a higher acre production, but the planter will likely have difficulty in persuading himself to destroy perfectly good trees when they begin to crowd one another.

It is readily seen that the picking of the crop from trees so tall as Excelsa is not an easy matter when the planting is on a steep slope. Even though most of the trees at the station have been topped at 12 feet, ladders

* By T. B. McClelland in *Agricultural Notes* of the Porto Rico Agricultural Experiment Station, No. 45, December, 1928.

have had to be used and on steep slopes that is difficult. It is quite probable that on steep slopes the trees should be kept at such a height as to make ladders unnecessary in harvesting the crop, even though the lower heading-back of the tree should result in a somewhat reduced production. On more nearly level land where ladders can be used the trees should not be allowed to grow above 12 feet in height. If the tree is allowed to attain this height before being topped, there will have been a loss of irreplaceable lower primary branches. The initial topping should be when the tree is small and still retains the first primary laterals. When four pairs of laterals have developed is a good time to top. Growth will then be forced into the laterals and they will develop into large branches. When they have become strong and well-developed, an upright branch may be allowed to grow from the trunk and carry the growth up to the desired height.

The leaves of Excelsa coffee are of much stiffer, heavier texture than those of the Arabian coffee and are larger, measuring 8 to 12 inches in length and 4 to 6 inches in breadth. They are much less subject to leaf miner injury. Although the leaf miner enters, it makes little headway. For localities where the ravages of this pest are excessive the planting of Excelsa coffee rather than Arabian is recommended.

The crop begins to ripen in December or January and continues into the following summer, thus ripening in the months when the Arabian coffee is not being picked and when labour is most readily available on the coffee plantations as constituted to-day. This variety is much less liable to loss from over-ripeness than is the Arabian coffee, and in consequence there may be longer interims between collections. The ripening season coincides with the drier weather, which favours the picking of the crop. Since the cherries are quite immature and many of them still small in the hurricane season, the probability of wind damage to the crop is less than in the case of the Arabian coffee, provided, of course, that the tree itself is not broken, blown over, or killed.

The pulp is firmer and less juicy than that of Arabian coffee. It is thinner, however, than that of some other members of the Liberian group to which Excelsa belongs, and the machinery ordinarily used in pulping Arabian coffee may be used for Excelsa.

The cherries on the average are smaller than those of the Porto Rican coffee but there is little difference between the two in bean weight. The loss in weight on removal of parchment is about 26 per cent for Excelsa in contrast to 17 per cent. for Porto Rican. While an almud of cherries of Porto Rican coffee is generally considered as the equivalent of 5 pounds of coffee beans after removal of parchment, an almud of Excelsa gives but 4 pounds of cleaned coffee. This makes the picking of Excelsa relatively more costly. The total reduction in weight from cherry to marketable bean in samples prepared at the station was in the ratio of 7·2 to 1. That is, for one pound of coffee as marketed, 7·2 pounds of coffee cherries were picked.

The bean is of a totally different appearence from the Porto Rican and for marketing purposes the two should not be mixed. The silver skin is of a pale brownish colour and the bean is straw-coloured or yellow. A considerable portion of the silver skin adheres to the beans, giving them a rough and uneven appearance, unless they are rapidly dried by artificial heat. A fragment of the parchment is likely to be held in the deep sutures, which also detracts from the appearance.

The quality of the beverage prepared from Excelsa coffee is good and would be acceptable locally. In marketing, this coffee could not be sold as Porto Rican, to which it is much inferior in appearance, but would be classed presumably as Liberian, to which it is more closely related.

The rate of production of Excelsa coffee in Porto Rico to date is shown in the accompanying table. Each of the four groups contains from 10 to 40 trees, but the production is raised in the table to an acre basis calculated on the area planted and a reduction rate of 5 liters of cherries to 1 pound of coffee after drying and the removal of the parchment. Each group except D, the smallest, has lost some trees. The production is accordingly smaller than had the stand been complete, but this is a normal condition and such as ordinarily might be expected on the plantation. Groups A and B are the oldest, and group A is the largest as well, originally set with 40 trees and now containing 37. In both groups the trees are spaced 12 x 12 feet. In A the trees were topped at 12 feet when a little less than 7 years old, in B the growth has been unchecked. In groups C and D the trees are spaced 10 x 10 feet. At six years the trees in C were topped at 12 feet and those in D at 6 feet, this operation in the latter group entailing some loss of crop. The soil in which these trees are growing is certainly not superior in fertility to that of the average coffee plantation, and some of it would be considered very poor. No fertilizer has been applied to it.

Annual Rate of Production per acre in Pounds of Coffee, Parchment Removed.

Age of trees	Group A	Group B	Group C	Group D
Years	Lb.	Lb.	Lb.	Lb.
5	57	33	—	—
6	275	168	64	41
7	238	187	55	139
8	652	417	209	—
9	204	814	211	—
10	970	28	348	—
11	585	63	—	—
12	946	895	—	—

The table shows that production began at 5 or 6 years from planting the seed, but that no large production was had under 8 years. In group A the average annual production from the 8th to 12th year was 671 pounds, a very satisfactory yield. In the smaller group B for the same period this was 443 pounds. In group C the production has been less satisfactory, which may be ascribed, at least in part, to late topping and too heavy shading.

In summing up, Excelsa coffee possesses certain advantages and certain disadvantages in comprison with the Arabian coffee grown locally. It is less exacting in its shade requirements and may even be grown without shade. Its adaptability to a dry climate renders it less subject to injury from a protracted dry season. The vigorous root development and rubust tree growth even on poor soils indicate this to be a promising variety for planting in many localities less suited to the more exacting Arabian varieties. Its resistance to the leaf miner is an attribute of paramount importance in some sections. The yield is comparatively high and the crop, ripening as it does in the drier months of the year, is much less liable to loss through wind or rain. The cup quality is good.

Against these good points, there are several less favourable characteristics. Excelsa is late in reaching full production. The reduction in weight on curing is high, an almud giving 4 instead of 5 pounds of cleaned coffee. On account of the less attractive appearence and small established demand for coffee of this type, the product would be less readily marketable at a good figure.

MEETINGS, CONFERENCES, ETC.

BOARD OF AGRICULTURE.

ESTATES PRODUCTS COMMITTEE.

Minutes of the forty-first Meeting of the Estates Products Committee of the Board of Agriculture held at the Head Office of the Department of Agriculture at 2-30 p.m. on Tuesday, January 8th, 1929.

Present:—The Acting Director of Agriculture (Chairman), the Government Entomologist, the Government Agricultural Chemist, the Acting Government Mycologist, the Hon. Mr. G. Brown, the Hon. Mr. T. B. Panabokke, the Hon. Mr. D. S. Senanayake, Messrs. H. D. Garrick, J. W. Oldfield, J. Horsfall, R. P. Gaddum, C. E. A. Dias, S. Pararajasingham, G. Pandittasekera, T. L. Cameron, A. W. Ruxton, E. F. Home, J. B. Coles, C. A. M. de Silva, A. T. Sydney-Smith, J. Fergusson, and T. H. Holland (Secretary).

Visitors:—Messrs. P. S. Bridge, N. K. Jardine, C. H. Gadd, J. Forbes, and V. Canagaratnam.

Letters or telegrams regretting inability to attend were received from the Government Agent, Northern Province, the Government Veterinary Surgeon, Gate Mudaliyar A. E. Rajapakse, the Hon. Mr. A. Mahadeva, Messrs. Maberley-Byrde, A. Coombe, N. D. S. Silva, G. D. Trevaldwyn, R. G. Coombe and Wace de Niese.

AGENDA ITEM 1.—CONFIRMATION OF MINUTES.

The minutes of the last meeting having been circulated to members were taken as read and confirmed.

AGENDA ITEM 2.—PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA, FOR THE MONTHS OF NOVEMBER AND DECEMBER, 1928.

Mr. Holland reviewed this report.

Mr. C. E. A. Dias remarked on the change of plan made in part of the Iriyagama Division where three different systems of drainage had been substituted for contour terracing. He deprecated this change and asked whether the sanction of the Committee had been sought.

The Chairman said that the Committee had not been consulted in the matter. He suggested that Mr. Dias should bring up the question under item 6 of the Agenda.

Mr. Dias expressed his unwillingness to vote for the adoption of the Progress Report owing to the change of plan to which he had referred.

The Chairman expressed the opinion that disapproval of this change did not constitute grounds for the non-adoption of the report. The report was finally adopted by the meeting.

The Hon. Mr. D. S. Senanayake then proposed that items 6 and 7 of the Agenda should be taken up next, and this proposal was agreed to. The items were as follows:—

AGENDA ITEM 6—BUDDED RUBBER.
AGENDA ITEM 7—RUBBER SEED GARDENS.

Mr. Dias first reverted to the change of plan made in the Iriyagam Division, and gave it as his opinion that the change made in a portion of the clearing invalidated the proper testing of mother trees. He considered that the planting of the portion of the clearing concerned should be scrapped and the whole clearing terraced as originally planned and replanted.

Copies of a letter written by Mr. Dias to the Secretary together with answers to the questions contained in the letter were tabled and the Chairman then dealt with these questions and their answers one by one.

With reference to the first question Mr. Dias was informed what mother trees were to be tested on the Iriyagama Division, as far as this information was available.

The answer to Mr. Dias' second question was that the size of a clone was 120 trees. In this connection Mr. Dias was referred to a paper entitled "Proposals for the Planting of the Irivagama Division of the Experiment Station, Peradeniya, with Budded Rubber for the testing of Mother Trees", which had been submitted to the Estates Products Committee in March, 1928.

With reference to Mr. Dias' third question the Chairman and Mr. Holland explained that there was no suggestion of testing stocks, or combinations of stocks and scions, nor had there ever been such a suggestion in this case. The planting of one "area" of 10 acres as far as possible with seedlings of one tree was done with the sole object of rendering the conditions of testing the mother trees as even as possible.

Mr. Dias said that Mr. Stockdale had always held that it was necessary to test the stocks first and he had understood that this was the policy to be adopted on the Iriyagama Division. He was glad to hear that the work would not be delayed on this account. He then stressed the importance of having four stocks in each hole to bud on to and of doing all the budding at the same time. If budwood was not available to bud the whole clearing at the same time he said that budding should be delayed until sufficient budwood was available. He suggested that the stocks laid down in nurseries for seed gardens should instead be transferred to holes in the clearing in order to have four stocks growing in every hole.

Mr. Holland pointed out that such a procedure would entail a departure from the principle laid down and agreed upon, namely, that each area of 10 acres should be planted as far as possible with seedlings of the same tree. He said that it was the intention to plant not less than three seedlings in each hole when seed from the same tree was available; he proposed as a modification of Mr. Dias' suggestion that when the 1929 seed was available all seed from the trees used in the first planting should be planted at stake in the appropriate areas and the question of whether further seed or seedlings from other trees should be put in to increase the stand of stocks should then be considered.

The Chairman said that he would like to see a small sub-committee appointed to consider this matter.

After some further discussion Mr. Dias put forward two concrete proposals :—

(1) That in those portions of the Iriyagama Division where drains had been dug instead of terraces the drains should be abandoned and the whole Division terraced on a uniform plan.

This resolution, seconded by Mr. A. W. Ruxton, was put to the meeting and was carried, seven voting for and none against. The remaining members did not vote.

(2) That four seedlings should be planted in each hole and that the policy of having one "area" planted with seedlings of one tree should be abandoned.

In supporting this proposal Mr. J. W. Oldfield proposed that the Chairman's suggestions of a small Sub-Committee to consider the matter should be adopted.

The meeting agreed to this course and the Chairman, Messrs. J. W. Oldfield, C. E. A. Dias and T. H. Holland were elected to form this Sub-Committee. These members agreed to serve.

The next suggestion in Mr. Dias' letter was that budded stumps from certain specified clones in Dutch East Indies should be imported for trial on the Iriyagama Division.

It was pointed out in reply that this would upset the planting plans for the Iriyagama Division and that the present scheme was for all plants budded with imported budwood to be planted at the Kegalle Experiment Station.

The Chairman however undertook to look into the matter and ascertain whether the clones in question were already represented at Kegalle.

Mr. Dias' fifth and last question related to Seed Gardens.

Information was given as to the number of mother trees to be used for these gardens and the proposed size and number of gardens. In reply to the question as to whether these gardens were in view the Chairman said that Mr. Stockdale had advised that the question of Seed Gardens should be postponed till the new Rubber Research Scheme Ordinance had been passed and the board of management of the new scheme set up.

In reply to a question as to when this was likely to occur, the Chairman said he had no information.

Mr. Dias then proposed that the work in connection with Seed Gardens should be proceeded with as early as possible without waiting for the passing of the new ordinance.

The meeting agreed to this course.

AGENDA ITEM 3.—NETTLE CRUB AND BROWN BUG IN UVA.

The Chairman said that Dr. Hutson had paid another visit to Uva in this connection but had unfortunately to cut short his visit on account of illness. He thought that the best course would be to put into operation the earlier suggestion that a subordinate officer should be detailed to reside for some time in Uva and study these pests on the spot.

The meeting agreed to this course.

AGENDA ITEM 4.—PUBLICATION OF A CONFIDENTIAL LETTER IN THE PRESS.

The Chairman read a letter from the Editor of the "Times of Ceylon" in this connection.

The meeting agreed that no furthur action was feasible and that the matter should be dropped.

Agenda Item 5 was dropped owing to the absence of Mr. R. de Zoysa.

At the conclusion of the meeting Mr. George Brown announced his intention of sending in for inclusion in the Agenda of the next meeting the question of the formal representation of the Tea Research Institute, the Rubber Research Scheme, and the Coconut Research Scheme, when formed, on the Estates Products Committee.

T. H. HOLLAND,
Secretary, E.P.C.

THE TEA RESEARCH INSTITUTE OF CEYLON.

THE First Conference of the Tea Research Institute of Ceylon will be held in the Board Room of the Head Office of the DEPARTMENT OF AGRICULTURE, PERADENIYA, on Monday, March 11th, 1929.

The Conference will be divided into Morning and Afternoon Sessions which will commence at 9-30 a.m. and 2 p.m. respectively, and time will be allowed for discussion of each Paper.

PROGRAMME.

MORNING SESSION.

1. Chairman's address and opening preliminaries.
2. Paper entitled, "Tea Factories" by Mr. F. J. Whitehead, Consulting Engineer, Tea Research Institute.
3. Paper entitled, "Some Problems in Tea Manufacture" by Dr. D. I. Evans, Bio-Chemist, Tea Research Institute.
4. Paper entitled, "The Relationship between Food Reserves of the Tea Bush and Disease" by Dr. C. H. Gadd, Mycologist, and Acting Director, Tea Research Institute.

AFTERNOON SESSION.

5. Paper entitled, "Experimentation with Tea" by Mr. T. Eden, Agricultural Chemist, Tea Research Institute.
6. Paper entitled, "Biologic Control in Entomology with special reference to Pests of Tea" by Mr. S. Stuart Light, Entomologist, Tea Research Institute.
7. Paper entitled, "Some Basic Principles of Agriculture as applied to Tea Estates" by Mr. E. E. Megget, Manager, Balangoda Group, Bogawantalawa.

A. W. L. TURNER,
Secretary,

DEPARTMENTAL NOTES.

REPORT ON KAPOK FROM CEYLON.

THE two samples of kapok which are the subject of this report were forwarded for examination to the Imperial Institute by the Director of Agriculture and are referred to in his letter No. A-571 dated the 14th September, 1928.

One of the samples was stated to consist of kapok from the Kurunegala District cleaned by means of a vertical machine with broad, thick blades which do not cut the fibres, and it was desired to ascertain whether material represented by this sample would be acceptable on the market.

DESCRIPTION.

(1) Hand-cleaned. Weight 1 oz.

This sample consisted of rather dark cream-coloured floss, soft and lustrous but somewhat lumpy in appearance. The floss was slightly stained in places and a few seeds and pieces of broken pod were present.

(2) Machine-cleaned matured kapok. May, 1928. Weight 9 oz.

This kapok was of rather lighter colour and not so lumpy as the foregoing sample, and was almost free from fragments of pod and seeds.

RESULTS OF EXAMINATION.

On examination the fibres were found to have the following dimensions, which are shown in comparison with those of the samples previously received from Ceylon and of a commercial sample of "prime" Java kapok.

Length in inches.

Present samples.		Previous samples.		
Hand Cleaned.	Machine cleaned.	Ceylon (1)	Ceylon (2)	Java
1·2	1·2	1·1	1·0	1·1
0·3	0·3	0·4	0·3	0·5
0·5 to 0·8	0·6 to 0·8	0·6 to 0·9	0·6 to 0·8	0·7 to 0·9
0·7	0·7	0·7	0·7	0·8

Diameter, in inches.

Present samples.		Previous samples.		
Hand Cleaned.	Machine cleaned.	Ceylon (1)	Ceylon (2)	Java
0·0011	0·0012	0·0014	0·0010	0·0010
0·0004	0·0004	0·0005	0·0004	0·0006
0·0006 to 0·0009	0·0006 to 0·0006	0·0006 to 0·0009	0·0007 to 0·0008	0·0008 to 0·0009
0·00073	0·0007	0·0008	0·00072	0·0008

It will be observed that as regards length and diameter the present samples were practically indentical, and similar to the previous samples from Ceylon. The length is slightly less than that of Java kapok. The machine-cleaned floss was cleaner and somewhat paler than the hand-cleaned product and was decidedly the better of the two; its resiliency appeared quite equal to that of Java kapok. Both samples were of much better appearance than those previously received from Ceylon.

COMMERCIAL VALUE.

The machine-cleaned kapok was forwarded for valuation to Messrs. Bastone Firminger, 4, Cullum Street, London, E.C. 3., who had reported on the earlier samples of Ceylon kapok received at the Imperial Institute. They described the present material as the best Ceylon Kapok which they had seen, adding that the fibre had not been shortened in the cleaning process and that consequently its resiliency was in no way impaired. They stated that as compared with the ordinary machine-cleaned Ceylon kapok in which they have hitherto dealt, the material showed the following advantages :—

(1) The resiliency is better than that of the ordinary product; (2) the kapok is of better colour and longer staple; (3) it contains "knobbly" floss, the presence of which has become popular with consumers, and which is not found to any extent in the ordinary machine-cleaned material now being shipped; (4) it shows a proper curly condition as against the more or less straightened fibres of the ordinary machine-cleaned product.

The firm also furnished the following general observations regarding kapok from Ceylon:

> "With regard to the question of demand for Ceylon kapok, although the present season has shown a very big decline in prices the demand has throughout the season been a good one, and this can be solely accounted for by the manner in which the Ceylon growers have gradually improved the quality of the kapok. Furthermore the growers have shown a considerable improvement in baling the kapok and likewise are now shipping bales press-packed with the Dutch pressure.
>
> "We would also mention that never before has the margin between Java and Ceylon kapok been so near, and it reflects to the greatest credit on Ceylon growers, as this satisfactory state of affairs has only been brought about by their increasing diligence and careful manipulation of the fibre.
>
> "We would also point out that there are quite a number of native shippers in Ceylon whose shipments are not altogether too reliable and as a consequence Ceylon kapok is still rather suspected by consumers. By this we mean to say they are uneasy in their minds as to whether they are going to get a good delivery or a poor one, which of course is not the case when Java kapok is contracted for."

The firm suggested that it should be shipped under the description of "superfine Ceylon kapok," in which case they considered that they would be able to obtain a very satisfactory price. They also emphasised the extreme desirability of packing the floss in a standard form, *i.e.* in bales of $1\frac{1}{4}$ cwt. each, with a measurement of 12 cu. ft., a method of packing which prevents the kapok from being over-pressed and preserves its characteristic qualities. If this can be done the firm are of opinion that they will be able to sell up to 500 tons per annum of Ceylon kapok of the quality represented by the present machine-cleaned sample and they will be pleased to take charge of shipments and obtain the best possible price on the market. In this connection it may be mentioned that hand-cleaned Java kapok is now quoted in London at $10\frac{1}{2}d.$ to $11d.$ per lb. Shippers are advised to communicate with the Director of Agriculture before sending consignments.

Imperial Institute, London S. W., 7.

29 November, 1928.

REPORT BY THE IMPERIAL INSTITUTE ADVISORY COMMITTEE ON SILK PRODUCTION.

THE question of the commercial prospects of sericulture in Ceylon, as regards both mulberry silk and Eri silk, has received the careful consideration of the Silk Committee who now submit their report. The work of the Committee has been facilitated by the action of the Director of Agriculture in forwarding for their perusal papers comprising a survey of the efforts made over a long series of years to establish silk raising in the Colony. The results of these experiments afford a valuable indication of the prospects of organising the production of silk as a commercial undertaking in Ceylon at the present time.

MULBERRY SILK.

The Committee note that experiments have shown that the mulberry silkworm can be raised with success in districts of the Island and that the cultivation of mulberry presents no difficulties. Further, they have no reason to doubt that silk produced in Ceylon, if raised by approved methods and under appropriate supervision, would be of a satisfactory quality. The committee believe, however, that there are two factors in the situation which would adversely affect the prospects of a mulberry silk industry to a degree that would render commercial success unlikely; namely, the religious objection raised by an important section of the community against the destruction of life involved in the stifling of the living cocoons before reeling; and also the doubtful attraction of silkworm raising to a population whose time is, generally speaking, fully engaged in the relatively well paid employment arising from the prosperous staple industries of the Colony. It may be pointed out that while sericulture is conducted as a part time occupation (and is not likely to be carried on with commercial success unless organised as a supplementary industry) the conditions of the silk trade at the present time are such that only the best qualities of silk are assured of a remunerative market. The production of fine quality silk calls for careful attention and supervision at all stages of the industry and such conditions require an expenditure of time which in Ceylon would probably be more profitably employed by work on the estates. The Committee note from the information supplied by the Director of Agriculture that in a previous attempt to raise mulberry silk in the Island the effort was discouraged by the low prices ruling for cocoons in Calcutta. It is perhaps a question whether, with careful attention to the production of the cocoons, it would not be possible to obtain a satisfactory price in the European markets. It is doubtful, however, if cocoons landed on the Continent would command 1*s*. 6*d*. per lb. which in 1915 appears to have been the minimum price at which cocoons would be offered by producers in Ceylon; while it should be noted that Ceylon cocoons would probably not fetch more than 1*s*. 0*d*. per lb. in Europe until they had become established in the market.

After full consideration of the position therefore the Committee do not feel justified in recommending the encouragement of mulberry silk raising in Celyon as an organised industry under the present economic conditions obtaining in the Island.

ERI SILK.

As regards Eri silk the Committee are also of the opinion that the production of this silk for export to Europe cannot be recommended at the present time. In former years Eri silk, which is classed as a waste silk, was regularly

employed in this country in the spun silk trade and was regared as a useful material for a number of purposes. At the present time, however, the market for Eri silk, outside India, is very small. Moreover, the present position of the waste silk industry in this country is very unsatisfactory owing to a variety of causes, the chief of which is the closing of markets which before the war were large buyers of spun silk fabrics. There is also the effect of the competition of artificial silk which has been found to be well adapted for purposes for which spun silk has hitherto been employed; while millinery fabrics which formerly absorbed large quantities of waste silks are not at present in demand. A revival of the use of waste silks in certain directions is not impossible but it is unlikely that any such improvement would involve an increased demand for Eri silk.

The Committee in 1927 dealt with a trial consignment of 1,000 lb. of Eri cocoons on behalf of the Government Silk Institute, Bhagalpur, Bihar and Orissa, with a view to testing the market for the silk in this country. The highest price obtainable for the cocoons was 2*s*. 6*d*. per lb. Recently, it has been ascertained that Eri cocoons are not likely to command a higher price than 2*s*. 0*d*. per lb. Enquiries made in India confirm the view that, at such values, the export of Eri cocoons from India would not be a commercial proposition, since equal or better prices for the cocoons are obtainable locally.

The Committee therefore are of opinion that the production of Eri cocoons in Ceylon for export to this country cannot be recommended, but they suggest that the cocoons might find a market locally, or possibly in India. The report on the examination of the Ceylon Eri cocoons, transmitted to the Director of Agriculture in July last, indicates that as regards technical characters cocoons of good quality can be raised in Ceylon.

In this connection the Committee note that in 1927 the question of Eri cultivation was the subject of consideration by a Committee of the Ceylon Legislative Council dealing with unemployment and that enquiries were being made as to the markets (presumably local markets) for the cocoons. The silk Comittee have received no further communication as to the results of the enquiries conducted by the Committee in Ceylon and would be much interested to be informed of the conclusions reached. They are of opinion, however, that, in the event of a decision to produce the cocoons for the Eastern market, the leaflet giving instructions for raising the Eri worm, prepared by the Department of Agriculture for distribution in the Colony (a copy of which was furnished by the Director of Agriculture) would admirably serve the object for which it was written.

Sgd. NORTON BRETON,

Chairman,

Imperial Institute,

Advisory Committee on Silk Production.

13 December, 1928.

PLANTAIN GARDEN COMPETITION, GALBODA—KINIGODA KORALES, 1927—1928.

A plantain garden competition was organised for Galboda and Kinigoda Korales in the Kegalla District during 1927-1928, when over 200 entries were received. At the commencement great keenness was shown by the competitors, but a good many of the competitors withdrew owing to the severe drought which prevailed during the early part of the year.

The preliminary judging was carried out by the Agricultural Instructor, and the final judging was done by the Divisional Agricultural Officer, Central, Peradeniya, in conjunction with the Assistant Government Agent, when the following were adjudged prize winners :—

GALBODA KORALE.

1.	Kongomuwa Junis Lebbe ...	Rs.	50·00
2.	Marasinpedige Siripina of Diwela, Undugama,	,,	40·00
3.	D. A. E. Wijemana of Kappagoda ...	,,	20·00
4.	Ana Adrihiman Lebbe of Attapitiya ...	,,	15·00

KINIGODA KORALE.

1.	Deliwela Aratchie ...	Rs	50·00
2.	Kiri Banda of Deliwela ...	,,	40·00
3.	E. M. Ukku Banda of Dombemade ...	,,	20·00
4.	Rajapakse Mudiyanselage Punchi Appuhamy of Yatacaulla ...	,,	15·00

Department of Agriculture,
Peradeniya, January 5, 1929.

REVIEWS.

THE REALM OF RUBBER.*

IT is rather difficult after reading through this book to decide for what section of the community it has been written. Any one connected with rubber-growing will probably agree with the author that there is room for a handbook on the rubber industry published in the English language, but it must be apparent to all that the whole of the ground cannot be adequately covered within the compass of 250 pages. The book cannot therefore have been intended seriously as a guide to working planters or others intimately concerned with any section of the industry. The fairly full discussion of the present position of the industry and its future prospects would indicate that the book might find a sale amongst investors in rubber shares who have no first-hand knowledge of the subject.

Even for this purpose the book is in many places misleading. Free use has been made of extracts from rubber journals and scientific papers but very little account has been taken of the dates of publication of the extracts. In a book published in 1928 some of the chapters can be aptly described as anachronisms. For example, on p.37 coagulation by the agency of lime juice is spoken of; also, the half-herring-bone system of tapping probably was last used about 1911 on more progressive estates. This is said to be the "method most generally adopted at the present time." Such mistakes are due to the extensive use of extracts from books written when plantation industry was in its infancy, and also, it must be suspected, to a lack of knowledge of his subject on the part of the author.

Other inaccuracies appear such as the method of budding described. The T-cut method has been tried with *Hevea* but it did not prove suitable and is not practised now. On p.97 it is said that coagulum is "run into sheets through machines, the hot rolls of which iron out its moisture." Comment on this is unnecessary to any one having a slight knowledge of factory practice.

A word must be said about the illustrations. A number of these are described as "photos prepared from drawings," a method which cannot be recommended. For example, that illustrating brown bast on p.201 would be of no use for purposes of diagnosis. That of pink disease on p.185 illustrates reasonably well the actual appearance of the diseased area but is misleading as the markings due to the external mycelium are about life size or very slightly reduced while the photograph of the tree on which the drawing has been superimposed is about one-fiftieth natural size.

It must be stated that the book under review can be of very little value to the rubber plantation industry. There is room for a handbook in which is collected the most recent information on modern practice but such a book must be written by someone with an intimate and up-to-date knowledge of his subject. The present volume does not adequately fill any vacancy.

R. A. T.

* By H. H. Ghosh, published by J. B. Daymond, Calcutta, 1928. Rs. 10.

INTERNATIONAL INSTITUTE OF AGRICULTURE.

INTERNATIONAL YEARBOOK OF AGRICULTURAL STATISTICS, 1927-28.

THE International Institute of Agriculture at Rome has recently published its *International Yearbook of Agricultural Statistics* 1927-28. This Statistical Yearbook has from the first been a special feature among the publications of the Institute, the first volume being issued in 1910 and others following in regular succession despite the special difficulties of the war period. The present Yearbook is actually the seventeenth of the series and as usual it contains a mass of agricultural data and material such as by the nature of the case are not to be found in any other publication of similar character.

An idea of its comprehensive nature may be gained by a glance at the subjects of the nine chapters into which this stout volume of nearly 600 pages is divided.

These are as follows: (*a*) Territorial area and population as in 1913 and in 1927 for 220 countries; (*b*) Apportionment of areas, agricultural production and numbers of live stock in 1926 and 1927 for 47 countries; (*c*) Area, production and yield per hectare for 35 agricultural products for all countries (averages for 1909-1913 and 1924-1927 respectively); (*d*) Numbers of the nine principal species of live stock for various countries; (*e*) Data of imports and exports relating to 40 vegetable and 5 animal products for various countries; (*f*) Prices for all the chief agricultural products; (*g*) Ocean freight rates for cereals and cotton; (*h*) Production, trade and consumption of chemical fertilizers; (*i*) Rates of exchange.

The statistical tables are elucidated and explained in an introductory chapter and the work as a whole will be found to be not only of great practical interest to persons directly occupied in agriculture, trade and finance, but also of very real assistance to all students of world economic problems as they present themselves to-day.

Rome, November, 1928.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JANUARY, 1929.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st. 1928	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	338	338	46	254	32	6
	Foot-and-mouth disease	10	10	4	...	6	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis	1	1	...	1	...	...
	Rabies*. (Dogs)						
Colombo Municipality	Rinderpest	Figures not yet to hand					
	Foot-and-mouth disease						
	Anthrax						
	Rabies (Dogs)						
Cattle Quarantine Station	Rinderpest	Figures not yet to hand					
	Foot-and-mouth disease						
	Anthrax						
Central	Rinderpest	33	33	...	32	...	1
	Foot-and-mouth disease	242	242	26	1	215	...
	Anthrax	...	...	...	...	...	...
	Black Quarter						
	Rabies (Dogs)	6	6	...	5	...	1
Southern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	787	787	607	26	154	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis						
Northern	Rinderpest	4	4	3	...	...	1
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	993	7993	7813	155	25	...
	Anthrax	...	...	...	...	...	...
North-Western	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
	Rabies (Horses)						
North-Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	26	26	26	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	164	164	72	1	90	1
	Anthrax	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	34	34	18	15	1	...
	Foot-and-mouth disease	1711	1711	592	11	1108	...
	Anthrax	...	...	...	...	...	...
	Haemorrhagic Septicaemia	7	7	...	7	...	...
	Pleuro-Pneumonia (in Goats)						

* A Dog and a Calf.

G. V. S. Office,
Colombo, 14th Febrary, 1929.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL
JANUARY, 1929.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	77·8	—0·8	79	2·5	NNW	102	6·61	10	+ 2·92
Puttalam	77·8	+0·9	76	3·2	NE	96	0·71	5	— 2·11
Mannar	79·3	+1·0	76	4·4	NNE	191	0·59	5	— 2·24
Jaffna	77·4	+0·4	80	4·2	ENE	82	1·01	5	— 1·66
Trincomalee	77·8	0	80	3·8	NE	122	2·85	5	— 3·77
Batticaloa	77·9	+0·1	82	4·0	NNE	174	0·44	5	— 9·96
Hambantota	78·3	—0·1	78	1·8	ENE	285	0·01	1	— 3·47
Galle	78·7	+0·4	79	4·9	Var.	125	1·25	4	— 2·96
Ratnapura	80·0	+0·2	72	3·8	—	—	8·55	13	+ 3·06
Anu'pura	75·3	—1·2	79	5·8	—	—	0·55	4	— 3·47
Kurunegala	78·2	+0·2	74	3·6	—	—	1·11	3	— 2·73
Kandy	75·0	+0·5	70	2·5	—	—	0,49	4	— 4·82
Badulla	69·6	—0·2	80	4·2	—	—	0·64	4	— 9·12
Diyatalawa	64·0	—0·4	75	3·4	—	—	0·44	3	— 5·75
Hakgala	59·4	+0·4	77	6·2	—	—	1·05	6	— 9·11
N.' Eliya	55·0	—2·5	74	4·2	—	—	0·22	2	— 5·62

January rainfall over almost the whole of Ceylon was in deficit, the deficits being most marked in the Eastern Province, and on the eastern and north-eastern slopes of the hills, districts which usually receive heavy rains during this month. The area having under 2 inches of rain comprised the greater part of the Eastern Province, where the average rainfall is usually 10-15 inches, and also extended over most of the hill-country, the Northern, North-Central, and North-Western Provinces, and the Eastern half of the Southern Province. The only stations showing excesses were all to the south and the west of the hills. Excepa, however, in a narrow strip of country just to the west of the hills, no station showed an excess of over 2 inches.

Only three stations recorded falls of over 5 inches in a day during the month, Deanstone, with 6·98, on the 26th, Dunedin, 5·20, on the 22nd, and Pelmadulla, 5·06 on the 8th.

An interesting feature of the month's weather was the occurrence of remarkably low temperatures at Nuwara Eliya on several nights. The minimum air temperature fell below freezing point on 5 days, the lowest reading being 27°·3, on the 14th, while the minimum on grass fell well below freezing point on 8 days, 7 of which were consecutive, the 13th to the 19th inclusive, the lowest reading being 20°·3 on the 14th. The minimum air reading of 27°·3 is very nearly a record for this station, while minimum air readings of 63°·3, 64°·0, and 63°·4 at Colombo on the 14th, 15th, and 16th were very little above the record for that station.

Humidity and cloud amount were generally below normal. The general wind direction was north-easterly, while the wind velocity at most places was below normal.

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